Geotechnical Investigation Report

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Bethany Home/Grand Canal Flood Control Project

Bethany Home Outfall Channel, Phase II

Project No. 98-46, PCN No. 620 03 32

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1.0 INTRODUCTION

This Geotechnical Investigation Report is submitted subsequent to an investigation performed by DMJM+HARRIS (DMJM) of the proposed Phase II segment of the Bethany Home Outfall Channel. The Phase II segment will begin approximately 1,250 feet east of 99th Avenue (at the terminus of the Phase I channel) and just north of the Grand Canal, and run easterly adjacent to the canal to just east of 83rd Avenue. The total project length is approximately 2 miles. The Project Site Vicinity Map is shown in Figure 1.

For the most part, the channel will be located immediately north of the Grand Canal. However, at about 88th Avenue, the channel will pass beneath the Grand Canal and be located to the south of the canal. Just east of 83rd Avenue, the channel will again pass beneath the Grand Canal and terminate on the canal's north side. The channel, will for the most part, be grass lined and contoured. Some of the wider segments will be developed for recreational purposes. Relatively flat side slopes, varying from about 6H:1V to 10H:1V (horizontal to vertical) are anticipated within these segments. In general, the channel invert will be constructed at depths of about 7 to 15 feet below existing site grades. Portions of the channel will also be constructed as either below grade concrete box culverts or open concrete sections with either vertical or sloped walls.

Bridge structures over the channel will be required at 91st Avenue and 83rd Avenue. It is anticipated that the bridges will be about 136 to 150 feet in length, and could consist of multi-spanned concrete slabs or precast pre-stressed concrete box beams with span lengths of about 35 to 45 feet. Box culvert structures will likely be utilized for the crossings beneath the Grand Canal at 88th Avenue and to the east of 83rd Avenue.

It is understood that pavements on 83rd Avenue and 91st Avenue will match the existing pavement sections. A new trail/maintenance road is planned along the length of the project. The Pre-Design Plans indicate a 16-foot wide road, which will be constructed outside of the channel limits. The road will be paved with asphaltic concrete (AC).

2.0 EXISTING DATA

A preliminary geotechnical investigation was prepared for this project during the pre-design stage by ATL, Inc. (1999). ATL performed three test borings within the original Phase II limits. Test Boring No. 1 was drilled near the intersection of 83rd Avenue and Bethany Home Road. The other borings were advanced at 75th Avenue and Camelback Road and 67th Avenue and Indian School Road, east of the current project limits.

The recommendations presented in this previous report were reviewed and incorporated within this report where deemed applicable to this segment of the project and final design. The log of Test Boring No. 1 and the applicable laboratory test data provided in the ATL report, are included with this report in Appendices C and D, respectfully.

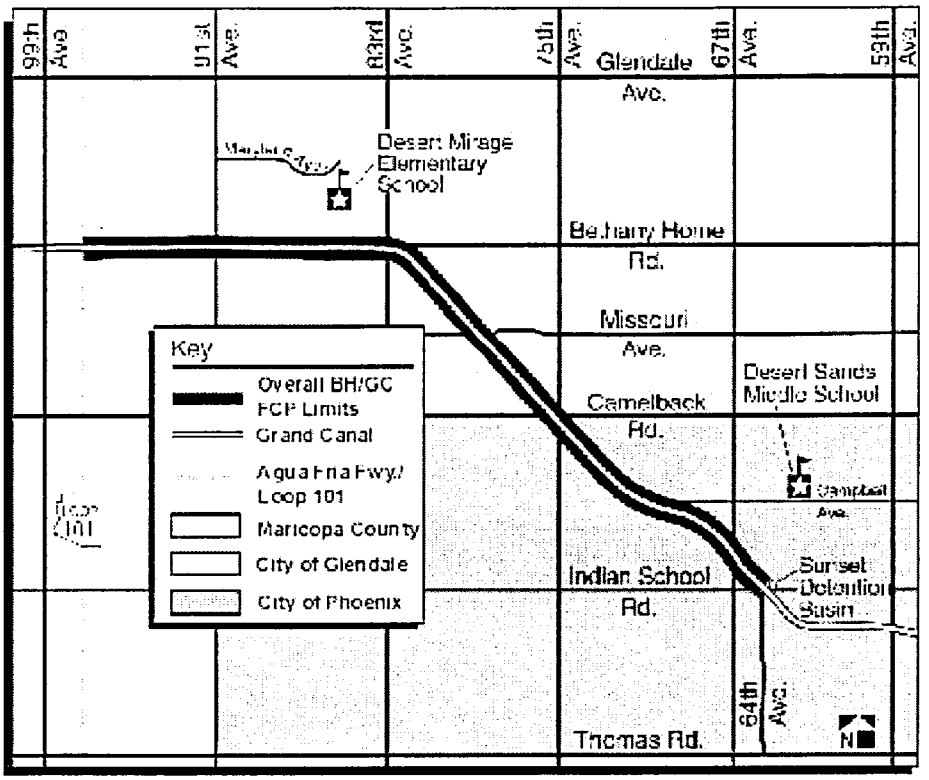


FIGURE 1

PROJECT SITE VICINITY MAP

3.0 FIELD & LABORATORY INVESTIGATION

Sixteen test borings were advanced for this final investigation to depths of about 15 to 81 feet using a truck-mounted Brainard Kilman 81HD drill and 8-inch O.D., hollow stem auger. Standard penetration tests and open-end drive (ring) samples were collected at intervals of 5 feet or less within the borings. Bulk samples of the auger cuttings were also collected at selected depths for laboratory testing. The soils encountered were visually classified by our field engineer and logs of the borings were prepared. The locations of the test borings are shown on the site plans (Sheets 1 through 5) presented in Appendix A.

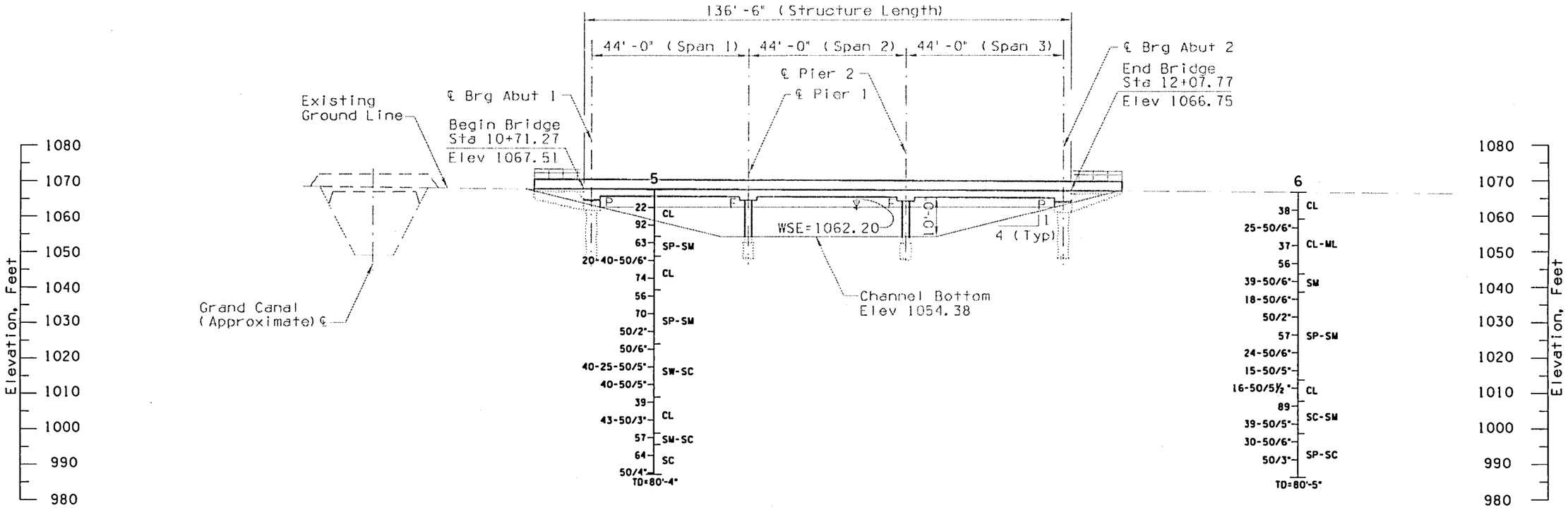
Laboratory testing was performed by ATL, Inc., on selected samples obtained from the test borings. The tests performed include moisture content, dry density, sieve analysis, Atterberg limits (plasticity index), direct shear, consolidation, moisture-density (standard Proctor), pH, sulfates and chloride. The moisture content and dry density results are presented on the boring logs. The other test results are presented in Appendix B.

4.0 SITE DESCRIPTION

The Phase II channel will parallel the Grand Canal either to the north or south from about 91st Avenue to about 600 feet east of 83rd Avenue. The Grand Canal, which typically flows full, is mostly lined with concrete and bordered on both sides by gravel paved access roads constructed at grade to partially raised embankments. A section of the canal is unlined extending from approximate project Stations 81+00 to 94+00 (to the west of 91st Avenue). High voltage overhead power lines are located along the south side of the canal.

The project alignment traverses both agricultural land and residential property. Although relatively flat, the alignment drops in elevation about 25 feet (0.2 percent slope) from the east to west. To the west of 91st Avenue, the alignment parallels the north side of the Grand Canal within existing cultivated fields. East of 91st Avenue to about 88th Avenue, the channel and an adjacent detention basin will be constructed between the Grand Canal and a single-family housing development to the north. At 88th Avenue, the channel passes beneath the Grand Canal and immediately to the south of the Salt River Project Welborn Substation. All of the property to the south of the Grand Canal, with the exception of the substation, is cultivated farmland which was fallow at the time of the investigation. East of 83rd Avenue the channel likely will be contained within a below grade box structure. This area is currently occupied by older homes. The channel will again pass beneath the Grand Canal at about 81st Avenue, as the canal swings to the southeast. The Phase II segment ends just beyond the canal.

Bridge crossings will be required at both 83rd Avenue and 91st Avenue. The existing streets consist of four-lane asphaltic concrete (AC) paved arterials.



LEGEND

1 (Boring No.)

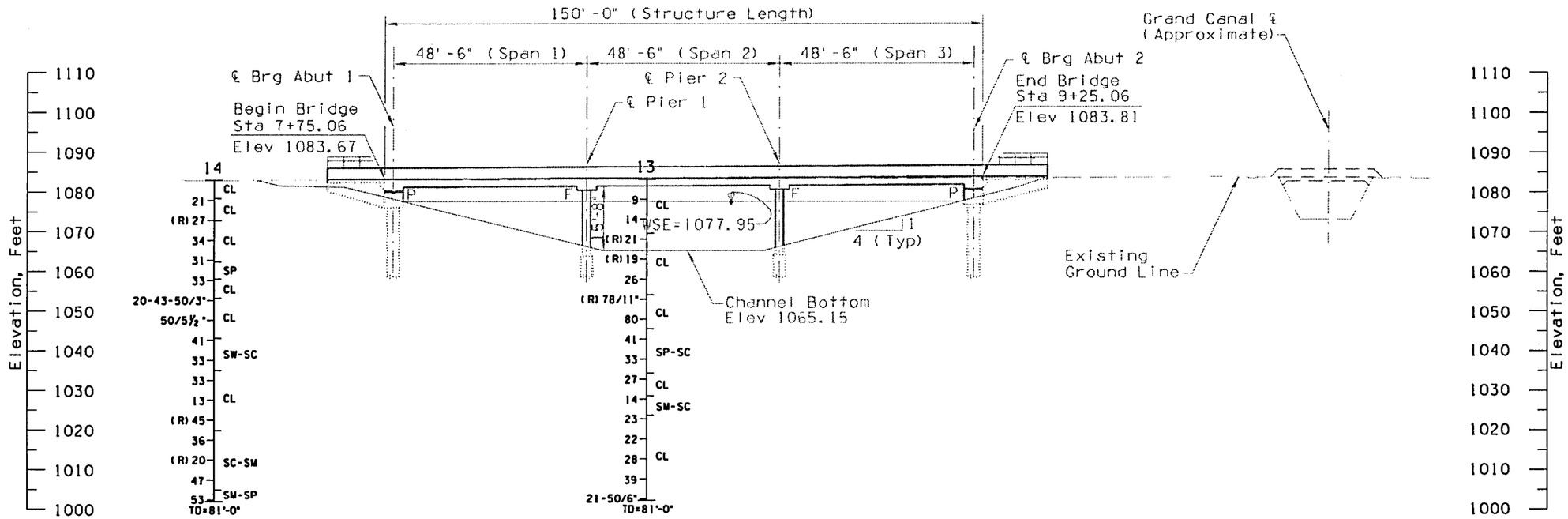
(Blowcounts, Per Foot) N 30 — SM, ML, CL (Unified Soil Classification)

Undisturbed Ring Sample (R) 41

TD=100' (Total Depth)

Geotechnical Profile @ Proposed
91st Avenue Bridge
(Looking West)

FIGURE 2



LEGEND

1 (Boring No.)

(Blowcounts, Per Foot) N 30 — SM, ML (Unified Soil Classification)

Undisturbed Ring Sample (R) 41 — CL

TD=100' (Total Depth)

Geotechnical Profile @ Proposed
83rd Avenue Bridge
(Looking West)

FIGURE 3

5.0 GEOLOGIC DESCRIPTION & GROUNDWATER CONDITIONS

5.1. GEOLOGIC DESCRIPTION

The project site is located within an alluvial deposition of the Basin and Range Province of central Arizona. The Basin and Range is characterized by isolated fault-bounded mountain ranges separated by broad non-faulted alluvial valleys. Bedrock is not exposed in the near project vicinity and the alluvium in the general area is known to extend to depths of more than 1000 feet.

5.2 GEOTECHNICAL PROFILE

Typically, the subsurface soils to depths of about 14 to 20 feet below existing site grades consist of fine grained silty to sandy clays and lesser layers of clayey sand, all of low to medium plasticity. The only exception encountered was in Boring No. 4 located west of 91st Avenue, where non-plastic sand was encountered below a depth of about 8 feet, extending to the full depth of the boring. The clayey soils are uncemented to weakly cemented with calcium carbonate and are generally moderately firm to firm in the upper 5 to 8 feet, becoming firmer with depth. The majority of the channel excavations will be completed within the upper clayey stratum. Below the surficial clayey layer are interbedded layers of low to medium plasticity clayey to silty soils and non-plastic layers of sand containing variable amounts of silt and clay. Predominantly non-plastic sand with small amounts of silt and clay was encountered within Borings 5 and 6 at about 29 feet extending to depths of 53 to 59 feet. The geotechnical profile at the 91st Avenue and 83rd Avenue bridge crossings, based on the completed test borings, are presented in Figures 2 and 3.

5.3 SOIL MOISTURE & GROUNDWATER CONDITIONS

Groundwater was not encountered in any of the test borings. The depth to groundwater, in the general site area, based on Hammet and Herther (1995) varies from about 120 to 180 feet. The moisture content of 33 samples tested in the laboratory varied from 3 to 42 percent. The moisture conditions described in the field typically varied from slightly moist to very moist, with isolated layers described as wet. The close proximity of the test borings to the Grand Canal likely contributed to the elevated moisture contents within various soil layers. However, the clay soils present near surface also likely provide a natural barrier to significant seepage from the canal.

6.0 ANALYSIS & RECOMMENDATIONS

6.1. GENERAL

Grass lined channels, constructed at slopes ranging from 4 to 6H:1V (horizontal to vertical) are planned within the majority of the Phase II project. From the west end of the project, east about 3,900 feet (to 91st Avenue), a channel with a bottom width of 85 feet and 6H:1V side slopes is planned. This portion of the channel will be contoured

and developed for recreational use. The channel invert will be about 8 to 10 feet below existing site grades. From 91St Avenue, east about 1,800 feet, the channel will be steepened to 4H:1V and the bottom width will be reduced to about 60 feet. For the remainder of the project, with the exception of two box culvert crossings below the Grand Canal and associated "U"-shaped transition structures, the channel will have a range of side slopes and a bottom width from 40 to 60 feet.

Multi-span bridge structures are planned at 91st Avenue and 83rd Avenue to span the proposed Phase II channel. Given the presence of the near surface moisture-sensitive clay soils, it is recommended that the structures be supported on drilled, cast-in-place concrete shafts. Drilled shafts will not be subject to significant movement should the upper clay soils experience substantial increases in moisture due to seepage from either the proposed channel or the adjacent Grand Canal. Drilled shafts will also be less susceptible to movements induced by scour, if applicable. Recommendations for drilled shafts are presented in Section 6.2.

Should adequate protection such as concrete cutoff walls or lining of the channel be provided to prevent scour, a continuous mat-type foundation, as an alternative to drilled shafts, could be considered. A continuous mat foundation would spread the vertical loadings to a significant degree, lessening the potential for moisture-related settlements. Isolated spread-type footings loaded in a similar manner would be subject to potential significant movements due to higher required bearing pressures. Recommendations for mat-type foundations are presented in Section 6.3. Recommendations for bridge abutment walls and wingwalls are presented in Section 6.4.

The soils present at the planned base of the box culverts and transitions at 88th Avenue and near 83rd Avenue are considered sufficiently firm in their existing condition for support of the anticipated loads. Scarification and recompaction of the exposed cut surface is recommended for moisture-conditioning purposes. Some variation in the condition of the soils which underlie the Grand Canal are anticipated from those encountered in the nearby test borings. Should soft, wet clay soils be encountered during construction, the soils should be overexcavated, modified, or replaced with higher quality materials. Design recommendations for box culverts are presented in Section 6.5.

The soils encountered within the upper 15 to 20 feet typically consist of finer grained medium plasticity clays. These soils will be stable at the intended slopes, and where cut or properly compacted as fill should possess sufficient cohesion for at least moderate resistance to erosion. The native soils are typically non-cemented to weakly cemented with calcium carbonate. Although agronometric testing was not performed, it appears that the clay soils will be suitable for development of plant growth without significant modification. Site grading is addressed in Section 6.6. Ponding of water in

low areas could become problematic due to the low permeability of the near surface clay soils. Proper site grading will be required to minimize such occurrences.

Based on the widely spaced test borings, it does not appear that seepage from the canal will significantly impact construction in terms of excavations. However, soft, wet zones, may be encountered and will need to be addressed on a localized basis during construction. The resident engineer assigned to the project should coordinate closely with a representative of the geotechnical engineer to deal with such issues. Further recommendations concerning excavations are presented in Section 6.7.

6.2. DRILLED SHAFTS

6.2.1. Vertical Capacity

Drilled shaft capacities for compressive loads were computed using the Beta method for free draining soils recommended by AASHTO, (1996). Vertical compressive drilled shaft capacities were estimated using the following equations:

$$Q_{ult} = Q_s + Q_t - W$$

Q_{ult}	=	ultimate compressive shaft capacity in kips
Q_s	=	ultimate shaft side resistance in kips
Q_t	=	ultimate shaft tip resistance in kips
W	=	weight of shaft in kips

where:

$$Q_s = \pi B \sum_{i=1}^{n} \gamma_i Z_i \beta_i \Delta Z_i$$

and:

$$\beta_i = 1.5 - 0.135\sqrt{Z_i}\ ;\ 1.2 > \beta_i > 0.25$$

B	=	shaft diameter in feet
β_i	=	load factor coefficient for load type i
Z_i	=	depth from ground surface to midpoint of ith soil layer (feet)
Z_i	=	thickness of ith soil layer (feet)
γ_i	=	unit weight of ith soil layer (pcf)
i	=	ith soil layer
n	=	number of ith soil layers

and:

$$Q_t = q_t A_t$$

in which:

q_t = unit shaft tip resistance in kips [determined in accordance with Section 4.6.5.1.4 in AASHTO]

A_t = shaft tip end area (square feet)

A factor of safety of 2.5 was applied to the ultimate compressive shaft capacities to determine the allowable capacities presented in the design charts. Effective soil unit weights varying from 100 to 125 pounds per cubic foot (pcf) were assumed for the various strata analyzed. Soils within 20 feet of existing ground were neglected in terms of developed shaft capacity based on the planned invert of the channel.

Figures 4 and 5 present the recommended allowable downward capacities of three-foot to seven-foot diameter straight, drilled, cast-in-place concrete shafts for the abutments and piers at both of the planned structures. The capacities apply to shafts spaced at least three times the shaft diameter (D), center to center (CTC). Should tighter spacings be required, a reduction in the total capacity shall be required due to group loading effects. Reduced capacities should also be considered if adjacent shafts constructed within 4D are to be constructed simultaneously. Reduced capacities due to group effects or adjacent construction, can be provided upon request.

The weight of the shaft within the bearing zone portion as described above, has been included in the calculations. Due to the general finer-grained nature of the soils encountered within the borings at both bridge sites, and the limited amount of gravel which was encountered within the borings, a minimum shaft diameter of three feet is considered acceptable.

Utilizing methods presented by Reese and Wright (1977), it is estimated that settlements of drilled shafts designed and constructed in accordance with the criteria presented herein will not exceed ¾ inch. In general, it is anticipated that the settlements will be less than ½ inch. Settlements should occur rapidly and be essentially complete following application of the superstructure loads.

6.2.2. Seismic Considerations

The project site is located within the Sonoran Zone described in the Arizona Department of Transportation (ADOT) report AZ92-344 (Euge, et al, 1992). The Sonoran Zone is not considered to be seismically active and is not located in the vicinity of a seismically active area. The maximum credible earthquake for the project area is conservatively estimated at a magnitude of 5.5. The ADOT report indicates a peak ground acceleration of about 0.026g with a 90 percent probability of non-exceedance in 50 years.

With respect to seismic design, the above range of acceleration coefficients would equate to a Seismic Performance Category (SPC) A, based on Table 3.4, Division 1A of AASHTO (1996). In accordance with Table 3.5.1, Division 1A of AASHTO (1996), the site soils should be considered as Type II.

Recommended Allowable Downward Capacity of Drilled Shafts - 91st Avenue Bridge

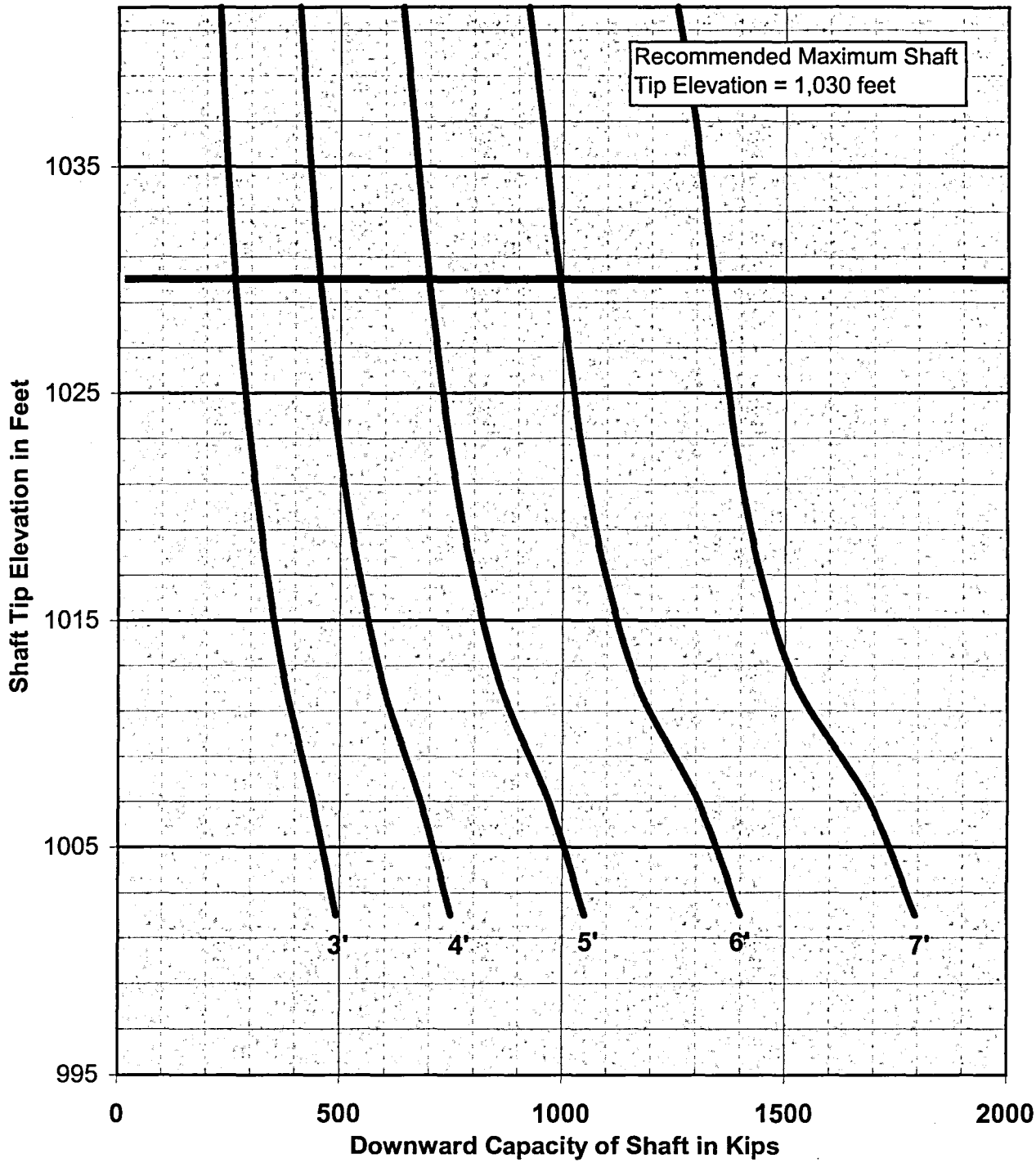


Figure 4

Recommended Allowable Downward Capacity of Drilled Shafts - 83rd Avenue Bridge

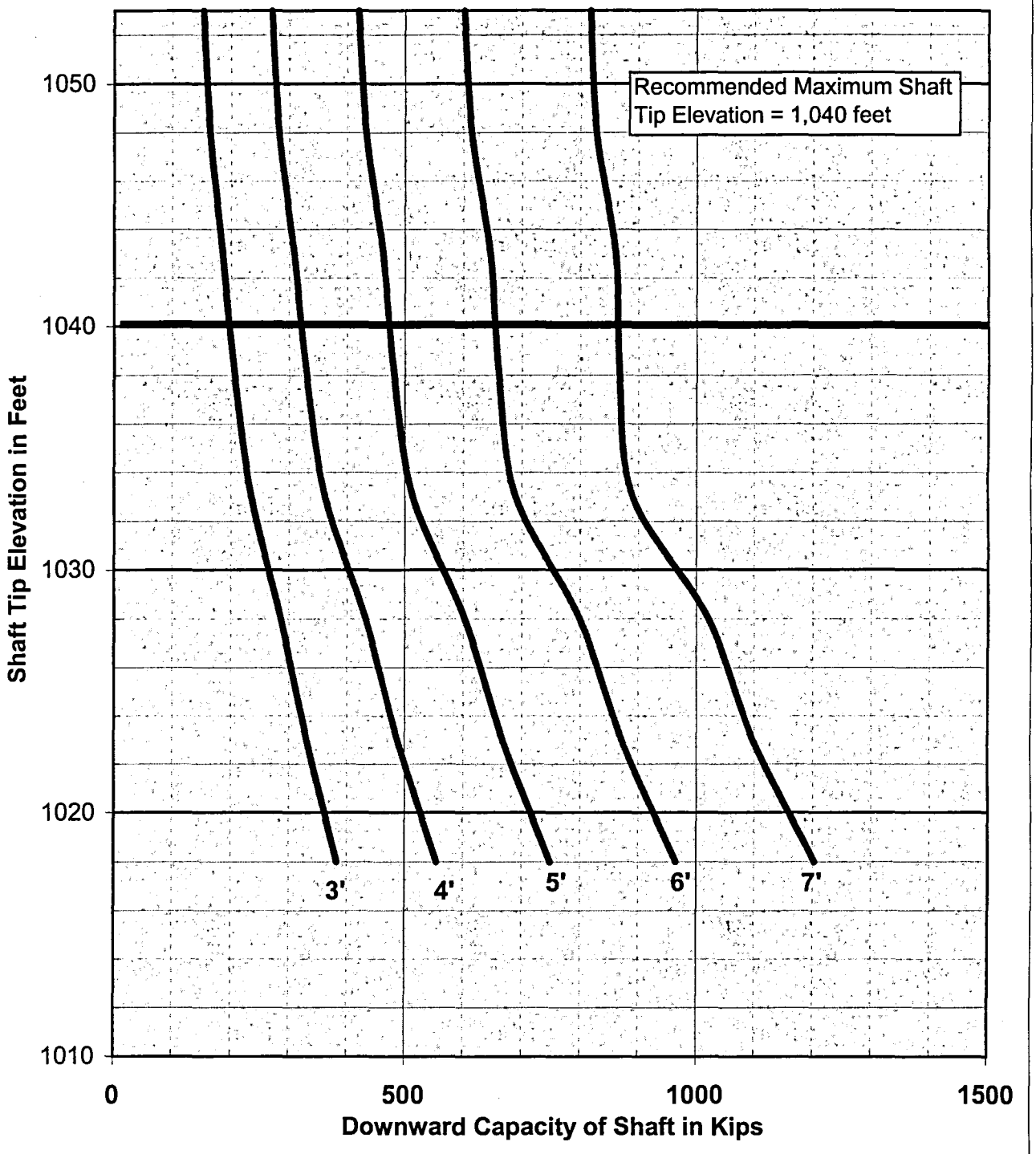


Figure 5

6.2.3. Lateral Soil Resistance

Lateral soil-structure interaction of single piers can be analyzed using various computer programs including COM624 or LPILE 3.0 Plus, etc. These programs estimate the lateral load-displacement behavior using a finite difference technique based on elastic beam column theory and p-y (soil reaction-displacement) curves. Deflection, bending moment, and shear profiles at specified intervals along the length of the pier are developed. Table 6.1 presents the recommended soil strength parameters for use in the above referenced programs.

Table 6.1 Recommended Soil Parameters for Input into Drilled Shaft Lateral Analysis Program

Location	Elevation Range (feet)	Moist Unit Weight (pcf)	Friction Angle (degrees)	Undrained Shear Strength (psf)	Soil Strain Ratio ϵ_{50}	Lateral Soil Modulus, k (pci)
91st Avenue Bridge	1043 to 1050	105	0	300	0.009	300
	Below 1043	115	33	0	0	225
83rd Avenue Bridge	1052 to 1060	105	0	200	0.015	150
	Below 1052	110	0	800	0.0065	1500

It is recommended that the shafts be modeled assuming stiff clay soils above the ground water table, as the upper portion of the shafts, which will be most influenced by lateral loading, will be supported mainly in finer grained clayey and silty soils. For programs which allow modeling of cohesive and non-cohesive within succeeding layers, the input codes for the two strata layers given at 83rd Avenue and the upper layer at 91st Avenue should be modeled as stiff clay. The underlying layer at 91st Avenue should be modeled as sand.

According to AASHTO Section 4.6.5.6.1.4, drilled shafts in a group may be considered to act individually when the CTC spacing is greater than 2.5D in the direction normal to loading, and greater than 8D in the direction parallel to loading. For shaft layouts not conforming to these criteria, the effect of shaft interaction should be considered in the design. Recommendation for group reduction effects can be provided upon request.

6.2.4. Drilled Shaft Construction

Drilled shafts should be constructed in general accordance with Section 712 of the Maricopa Association of Governments (MAG) Specifications. Based on the test borings and our experience with drilled shafts constructed in the general project vicinity, specialized stabilization techniques such as casing or slurry will likely be needed at the 91st Avenue location to prevent excessive caving of more sandy soils. The depth of penetration of the shafts into the sandy soils will be a factor in determining the need for stabilization. Stabilization might also be required at 83rd Avenue, although the soils encountered in the test borings are clayey in the upper 40 feet. The clayey soils should

eliminate the need for surface casing, however stabilization of the deeper soils may be necessary.

Observation of the drilled shaft construction should be performed by a representative of the geotechnical engineer to verify the nature of the materials encountered, proper shaft depth and diameter, cleaning of the shaft base, rebar cage installation and concrete placement. A quality control report should be submitted on each shaft stating that all details were monitored and meet the project requirements.

6.2.5. Test Shaft

Based on the test borings, it appears that potential for excessive caving does exist at the 91st Avenue bridge location, and that some caving should be anticipated at 83rd Avenue. Given that only two test borings were performed at each location, it is recommended that a test shaft also be performed for each site. The test shaft should be constructed to the same depth and diameter as the production shafts. A test shaft report should be prepared documenting the drilling equipment and methods employed including any specialized stabilization techniques, drilling rates, etc. A detailed log of the materials encountered within the shaft should also be prepared by a representative of the geotechnical engineer. As discussed above, the amount of penetration into the sandy soils present at depth will determine the need for stabilization during construction.

The intent of the test shaft is to permit prospective drilling contractors to observe the subsurface conditions at a select on-site location. It is not intended that the conditions encountered within the test shaft will be representative of either the entire project site nor of the immediate bridge site, as variations in the geotechnical profile do exist. The purpose for the test shaft is to provide supplemental information to the geotechnical investigation performed for the project. The test shaft and Test Shaft Report should not supercede the recommendations presented in the Foundation Design Report, and the drilling contractor should be responsible for reviewing all available information.

6.2.6. Load Test

A load test to verify or modify the vertical shaft capacities is not considered to be necessary for this project, due to the typical high costs associated with such a test. Relatively high soil strength parameters were utilized to develop the recommended vertical capacities of drilled shafts presented in Figures 4 and 5. The cost savings, assuming a reduction of the design safety factor for shear and end bearing from 2.5 to 2.0 (in accordance with Section 4.6.5.4 of AASHTO and possible further reductions due to the results of the test), likely would not warrant the expense of a test.

6.3. SHALLOW, MAT-TYPE (BOX STRUCTURE) FOUNDATIONS

6.3.1. Vertical Capacity

Provided that mat-type foundations at the base of box bridges at 91st Avenue and 83rd Avenue are embedded to a depth of at least 3.0 feet below the planned channel invert, and that adequate scour protection will be installed to prevent loss of ground, a maximum allowable bearing pressure of 3.0 kips per square foot (ksf) may be utilized for design. The allowable uniform bearing pressure is based on Section 4.4.7 of AASHTO (1996), and the lower bound averages of SPT values obtained within the test borings. The exposed surface beneath the structure should be scarified to a depth of eight inches, moisture conditioned, and compacted to a minimum of 95 percent of the maximum standard Proctor (ASTM D698) density. Additional overexcavation beneath the structure is not considered to be necessary. However, if loose or soft zones are present at the base of the excavation, such that compaction cannot be achieved, those soils should be removed and replaced with compacted structural backfill. Materials recommended for use as structure backfill are presented in Section 6.6.5.

6.3.2. Passive Lateral Soil Resistance

The use of passive lateral soil resistance in design, should be in conjunction with the potential for scour and planned mitigation measures for the specific structure foundation. It is recommended that at an absolute minimum, the passive lateral soil resistance be neglected to within 3 feet of finished channel invert. Below a depth of 3 feet, the passive lateral soil resistance against the edges of mat-type footings, wall stems and other vertical foundation elements, in contact with properly compacted backfill or native soil, may be considered as being equal to the force exerted by a fluid pressure of 300 pounds per square foot (psf) per foot of depth. A coefficient of friction of 0.40 is recommended for computing the lateral resistance between the base of the mat-type footing and the underlying soils when analyzing lateral loads.

6.3.3. Concrete Slabs, Cast-on-Grade

A coefficient of subgrade reaction of 150 pounds per cubic inch (pci) should be utilized for the design of concrete slabs supported on compacted native subgrade soils, as discussed in Section 6.6. This value may be increased to 250 pci for slabs cast on a minimum of 6 inches of granular base backfill.

6.4. BRIDGE ABUTMENT WALLS & WINGWALLS

6.4.1. Vertical Pressures

Integral wingwalls likely will be used for box-type structures and associated transitions, or at bridge abutments founded on drilled shafts. Where limited differential movements relative to the bridge structures are required, the foundation for the wingwalls likely should match the type used for the bridge. If scour protection is provided, shallow

spread-type footings could be utilized for foundation support of wingwalls, adjacent to a mat-type foundation. Conversely, drilled shafts likely should be used for support of wingwalls attached to a drilled shaft supported bridge. Shallow spread-type footings could be utilized for support of wingwalls with a drilled shaft supported bridge if some differential settlements (up to ½ inch) are acceptable. Spread footings should not be used in any case if adequate scour protection is not provided.

6.4.2. Lateral Earth Pressures

The earth pressures against wingwalls, abutment walls or vertical channel walls will depend upon the degree of restraint. Rigid, absolutely restrained walls will be subjected to earth pressures represented by a hydrostatic load diagram of about 55 psf per foot of depth. Rotation or lateral translation of the walls equal to about 0.001 times the height will reduce earth pressures to the active state represented by a hydrostatic load diagram of about 35 psf per foot of depth. The recommended fluid pressures are based on the walls having horizontal backfill. If sloping backfills are used, modified pressures can be provided upon request. These recommended values should be modified to account for anticipated liveload or construction surcharges.

Free-draining granular backfill should be utilized behind wingwalls and abutment walls. This material should meet the requirements for granular base, presented in Section 6.6.6. This material should be compacted to at least 95 percent of maximum dry density in accordance with ASTM D698.

6.5. DESIGN OF BOX CULVERTS

The earth pressures imposed on buried, rigid, reinforced concrete box culverts are dependent upon support conditions, the placement and density of backfill, and the surcharge due to roadways or embankments above the box culverts. For the design of box culverts, earth pressures may be developed for an embankment condition provided the following criteria are adhered to:

- The backfill material surrounding the structure is as dense as the in-place natural soils at the site.
- The depth to an incompressible stratum is at least twice the width of the culvert.

The total vertical and lateral earth loads imposed on individual barrels within the box structure (based on Section 6.2 of AASHTO, 1996) should be calculated based on the following:

Vertical Earth Pressure = 120 lb/ft^3
Lateral Earth Pressure =
Case 1 – 30 lb/ft^3
Case 2 – 60 lb/ft^3

It is not anticipated that groundwater should impact the design of the box culverts. Consideration for hydrostatic uplift should however be given to box structures located immediately adjacent to the Grand Canal. The use of weepholes in combination with the granular wall backfill may lessen the potential for uplift of the structure.

6.6. SITE GRADING

In general, site grading for the project should be performed in accordance with the current Uniform Standard Specifications for Public Works by the Maricopa Association of Governments (1998), incorporating the following:

6.6.1. General Channel and Site Grading

The entire project limits should be cleared of all existing vegetation, debris, rubble and other deleterious materials. Compaction of the exposed surfaces all unlined channels is not considered to be necessary. Areas which are subjected to heavy compaction during earth moving operations should be scarified to a depth of 12 inches and recompacted after operations are completed at a lower density (90 percent of standard Proctor density) in order to accommodate future plant growth. Any embankment fills required, which will not support structures, should be compacted to 90 percent of standard (ASTM D698) density, within two percent of the optimum moisture content.

6.6.2. Grading Beneath Structures

For support of box structures, mat-type bridge footings, wingwall footings or concrete lined channel sections, embedded at least 5 feet below existing site grades, and to the minimum depths indicated in the previous sections, the exposed surface should be scarified. The scarification should extend to a depth of 8 inches and the soils should be recompacted to a minimum of 95 percent of standard Proctor density, within the range of minus 1 to plus 3 percent of the optimum moisture content. Prior to scarification, the exposed footprint should be observed by a representative of the geotechnical engineer for the presence of man-made fill or additional loose or soft zones. Should unsuitable materials be encountered, the materials should be overexcavated and replaced with either structural fill or low strength (one sack) sand-cement slurry.

If concrete lined channels which extend to the existing ground surface are to be constructed, it is recommended that the upper 2 feet of existing soils present within 8 feet (horizontally) of the lining be overexcavated and recompacted to a minimum of 95 percent of standard Proctor density, to within minus 1 to plus 3 percent of the optimum moisture content. This recommendation is based on the presence of disturbed, soft surficial soils which exist in the farm fields.

6.6.3. Grading Beneath Trail/ Maintenance Road Pavements

Soils beneath new pavement sections should be overexcavated, scarified and recompacted as necessary to provide a minimum of 12 inches of compacted subgrade. The soils should be compacted to a minimum of 95 percent of maximum standard Proctor Density determined in accordance with ASTM D968. The moisture content of the soils during compaction should be maintained within 2 percent of the optimum moisture content. Soils which meet the requirements for channel fill in Section 6.6.4, will be acceptable as compacted fill beneath the pavement section.

6.6.4. Channel Fill and Topsoil

Channel fill which may be utilized to achieve final grades within the channel and to construct embankments if necessary (in non-structural areas) should consist of materials with no particles larger than 3 inches. Organic materials, if present, may be reused only in areas designated for unlined channel sections and may not be used beneath structures, lined channels or pavements. The plasticity index of channel fill soils should not exceed 30. In general, most of the materials excavated from within the project limits should be suited for use as channel fill. Some sorting or blending may be required to limit the plasticity of a small percentage of the soils.

Agronometric testing for potential topsoil was not within the scope of this project. Soils considered for use as topsoil should be tested for conformance and modification requirements. It appears that the majority of near surface clayey soils would be suitable for use as top soil without significant amendments.

6.6.5. Structural Backfill

Structural backfill placed beneath structures in areas requiring overexcavation should meet the following requirements:

Item	Requirement
Percent Finer than 6-inch	100
Percent Finer than No. 200	45 (Maximum)
Plasticity Index	15 (Maximum)

Significant quantities of materials present within 20 feet of existing site grades, which meet the requirements for structural fill, do not appear to be present and importing of the soils will likely be necessary.

6.6.6. Granular Wall Backfill

Fill placed within 2 feet (measured horizontally) of all bridge abutment walls, wing walls, and shotcrete or concrete lined channel sections (either sloped or vertical) should consist of free draining granular base backfill meeting the following requirements:

Item	Requirement
Percent Finer than 3-inch	100
Percent Passing No. 4 Sieve	30 – 75
Percent Finer than No. 200	12 (Maximum)
Plasticity Index	5 (Maximum)

Granular wall backfill materials should be compacted to a minimum of 95 percent of the maximum standard Proctor density and to within two percent of the optimum moisture content.

Materials placed behind walls within 3.0 feet of finished ground, should consist of finer grained, low permeability soils that will tend to reduce surficial seepage into the granular backfill placed behind the walls. These materials should not be used however in areas which will be overlain by pavements, or other structures. The fine-grained soils should meet the following requirements:

Item	Requirement
Percent Finer than No. 4	100
Percent Finer than No. 200	50 (Minimum)
Plasticity Index	10 –25

The fine grained capping soils should be compacted to a minimum of 95 percent of the maximum standard Proctor density and within the range of minus 1 to plus 2 percent of the optimum moisture content.

The walls should be constructed with adequate weep holes to evacuate excess water from behind the walls. Materials which meet the requirements for common fill may be utilized directly behind the walls provided that geocomposite wall drains, such as TC Mirafi G100N, or an approved equal, are used against the wall in combination with adequate weep holes.

It does not appear that any materials excavated from within the project limits will meet the requirements for granular wall backfill. Considerable material will however be available for the finer grained surface capping layer.

6.7. EXCAVATIONS

6.7.1 Excavation Conditions

Based on the test borings, conventional earthmoving equipment likely can be utilized to perform all required excavations on this project. It does not appear that significant hard or strongly cemented layers, which would necessitate ripping are present within the upper 20 to 25 feet of existing site grades.

6.7.2 Temporary and Permanent Excavation Slopes

In general, temporary excavation slopes should be performed in accordance with OSHA Health and Safety Standards for Excavations, 29 CFR Part 1926, Subpart P. In accordance with Subpart P, Appendix A, the near surface clayey soils would be considered to be Type "B" soils. For excavations of less than 20 feet in depth, Subpart P, Appendix B indicates a maximum allowable unshored slope of 1H:1V.

Should steeper slopes be required due to proximity to existing structures or for purposes of economy, stability analyses should be performed by a registered geotechnical engineer. Likely steeper slopes will be feasible if confirmed through stability analysis.

Flatter excavation slopes may be required in some areas if loose man-made fills or uncemented, relatively clean, sandy to gravelly soils are encountered. Caving sandy soils are anticipated in the vicinity Test Boring No. 4 (Station 45+00). Temporary excavations, if performed in this area, likely will need to be sloped back no steeper than 1.25H:1V. Steeper slopes likely will require the use of trench shields or shoring. Although groundwater was not encountered within the test borings, moist to wet conditions were observed from samples collected at various depths within the borings. Should seepage from the adjacent Grand Canal be encountered during construction, slopes within those areas may need to be flattened.

The perimeter of all temporary excavations should be protected against surface water runoff with berms or other measures at the top of the slope. Moderate to severe raveling and erosion of the slopes could occur if impacted by runoff.

Permanent cut slopes should be constructed no steeper than 1.0V:1.5H, provided that the slope is covered with a concrete or shotcrete lining. Unprotected slopes should be laid back to at least 4H:1V to minimize surface erosion. Vegetating the slopes with grass will inhibit erosion at low velocities. Likely, clayey soil vegetated slopes will be stable provided flow velocities do not exceed about 5.5 to 6 feet per second (Flood Control District of Maricopa County, 1996). Preliminary hydraulic analyses indicate 100 year flood velocities typically within the range of 2.5 to 5 feet per second.

6.7.3 Earthwork Factors

The average in-place dry unit weight of 10 undisturbed ring samples of clayey soils obtained within 20 feet of existing ground was 104.3 pcf. The average 95 percent standard proctor density value, determined from five moisture-density relationship tests was 104 pcf. The average earthwork factor based on the above results is 0 percent shrink when comparing the in-place densities to the 95 percent values. Based partly on these results and mainly with our experience from other projects, it is recommended

that an earthwork factor of 8 percent shrink be used for cost estimating. This factor is based on the assumption that the excavated materials will be recompacted at 95% of standard Proctor density within the project limits, where handling and wind losses will be of limited extent. It is anticipated that higher shrink (10 percent or higher) will occur for materials excavated within 5 to 10 feet of existing ground, resulting in the overall estimate. A ground compaction factor of 0.05 feet is recommended for cut sections at depths of more than 5 feet below existing site grades.

6.8 PIPE BEDDING & BACKFILL

Pipe bedding and backfill should be done in conformance with Section 601 of the MAG Uniform Standard Specifications (1998). Jetting, as a method of compaction, is not recommended given the high percentage of clay soils. If performed, the contractor should be experienced with jetting and be prepared to drain the trench of all accumulated water.

6.9 CORROSIVITY OF SITE SOILS

Preliminary laboratory testing for pH, sulfates and chlorides was performed for this project, and the results are presented in Appendix B. The tests were performed to determine the potential for soil induced corrosion on concrete pipes. The pH of the four samples tested vary from 8.1 to 8.6. The results indicate favorable conditions relative to the use of Type II cement for pipes and structures. The sulfate and chlorides varied from 12 to 55 parts per million (ppm) and 30 to 130 ppm, respectively.

6.10 TRAIL/ MAINTENANCE ROAD PAVEMENTS

It is understood that cross-road pavements at 91st Avenue and 83rd Avenue will be designed to match existing pavements. Conventional asphaltic concrete (AC) over aggregate base (AB) pavement sections and alternative full depth AC sections for the trail/maintenance road, presented below, are based on the subgrade materials encountered within the test borings and anticipated light traffic loading conditions. All pavement sections should be underlain by a minimum of 12 inches of compacted subgrade, as discussed in Section 6.6.3.

Item	Thickness of Aggregate Base (Inches)	Thickness of Asphaltic Concrete (Inches)
Conventional AC Over AB Section	4.0	2.0
Full Depth AC Section	-	3.0

A ¾ (19mm) aggregate is preferred over a ½ (12.5mm) aggregate within the AC section to limit pavement fatigue due to traffic during high summer temperatures. Design of AC pavements should be in accordance with Section 321 of MAG (1998). The Marshall mix design is considered to be acceptable for design of the AC pavement. Aggregate base course should conform to Section 702 of MAG. If a Superpave mix design is utilized, a

seal coat should be applied to the finished surface to reduce permeability and loss of support through the section.

7.0 ADDITIONAL SERVICES

The geotechnical investigation for this project was performed based upon the negotiated scope of work for the project. The number of test borings and general locations of the borings were as directed by the Flood Control District of Maricopa County. In general, the borings completed to date appear to provide sufficient information for final design. At the time of our investigation, bridge configurations and types for the 91st Avenue and 83rd Avenue structures had not been established. Current plans now indicate three-pan structures at each location.

Two borings were advanced at each structure in accordance with the scope of work. It was intended that the borings be drilled at approximate abutment locations. The intended boring locations could not be accessed due to right-of-way constraints and buried/overhead utilities, the borings were offset from the planned locations. Given that the borings are offset from the intended foundations, some variability is likely to exist from the conditions encountered in the test borings and that which will be encountered during construction. It is recommended that either additional borings (at least two per structure) and/or a test shaft at each structure be considered to further identify the subgrade conditions, and reduce the potential of encountering different conditions during the construction of drilled shafts.

Other project elements which may require added services could include stability analysis of excavations, shoring for excavations, or handling seepage issues on an as-needed basis. DMJM+HARRIS would be pleased to provide these additional services at the request of the FCDMC.

8.0 CLOSURE

The recommendations presented in this report are based on a limited number of small diameter test borings, laboratory test data, our understanding of this project and our general experience in the project area. The subsurface conditions identified are based on the conditions encountered only at the specific test locations and it is anticipated that the subsurface conditions will vary somewhat between test locations.

This report was prepared for the exclusive use of the Flood Control District of Maricopa County, in accordance with the generally accepted standard of practice in Arizona and no warranty, expressed or implied is made. The scope of this project did not include an investigation for contaminated or hazardous materials. If the owner is concerned about the potential for such conditions, additional studies should be performed.

REFERENCES

American Association of State Highway and Transportation Officials (AASHTO), 1996, *Standard Specifications for Highway Bridges, Sixteenth Edition*, Washington, D.C. and recent interims.

ATL, Inc., 2000, *Revised Geotechnical Investigation Letter Report, Bethany Home Road Outfall Channel – Phase II*, FCD 98-46, Pre-Design Stage, ATL Job No. 199027, January 21, 2000.

Euge, K.M., and Others, 1992, *Development of Seismic Acceleration Contour Maps for Arizona*, Arizona Department of Transportation.

Flood Control District of Maricopa County, 1996, *Drainage Design Manual for Maricopa County, Volume II, Hydraulics, January.*

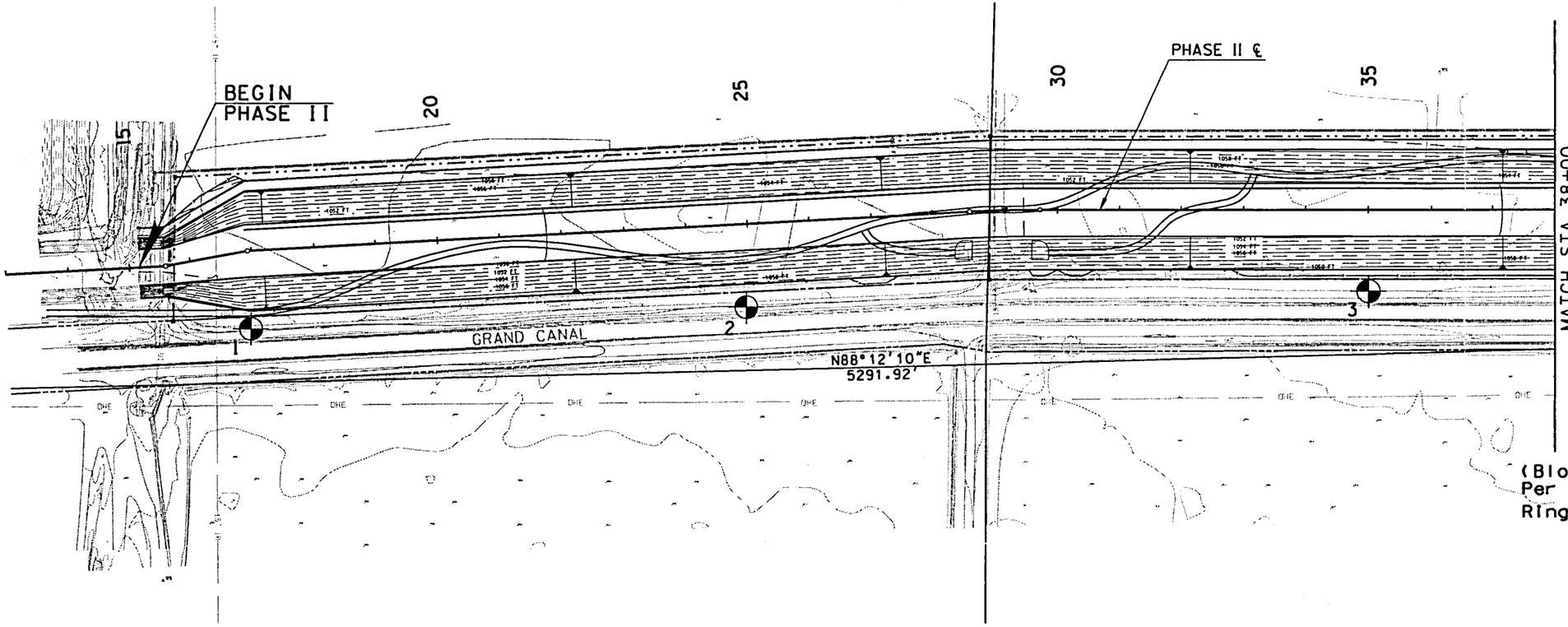
Maricopa Association of Governments, 1998, *Uniform Standard Specifications for Public Works Construction,* Including Revisions through 1999, Arizona.

Occupational Safety and Health Administration, 1999, OSHA Regulations (Standards – 29 CFR) Sloping and Benching – 1926 Sulopart P, September.

Reece, L.C., & Wright, S.J., 1977, *Drilled Shaft Manual, Construction Procedures and Design for Axial Loading, Vol. 1*, USDOT Implementation Package 77-21, Federal Highway Administration, Washington, D.C.

NAVFAC DM-7.2, *Foundations and Earth Structure Design Manual 7.2*, May 1982.

APPENDIX A – SITE PLANS & TEST BORING LOGS



N

50 0 50 100
Scale in Feet

LEGEND

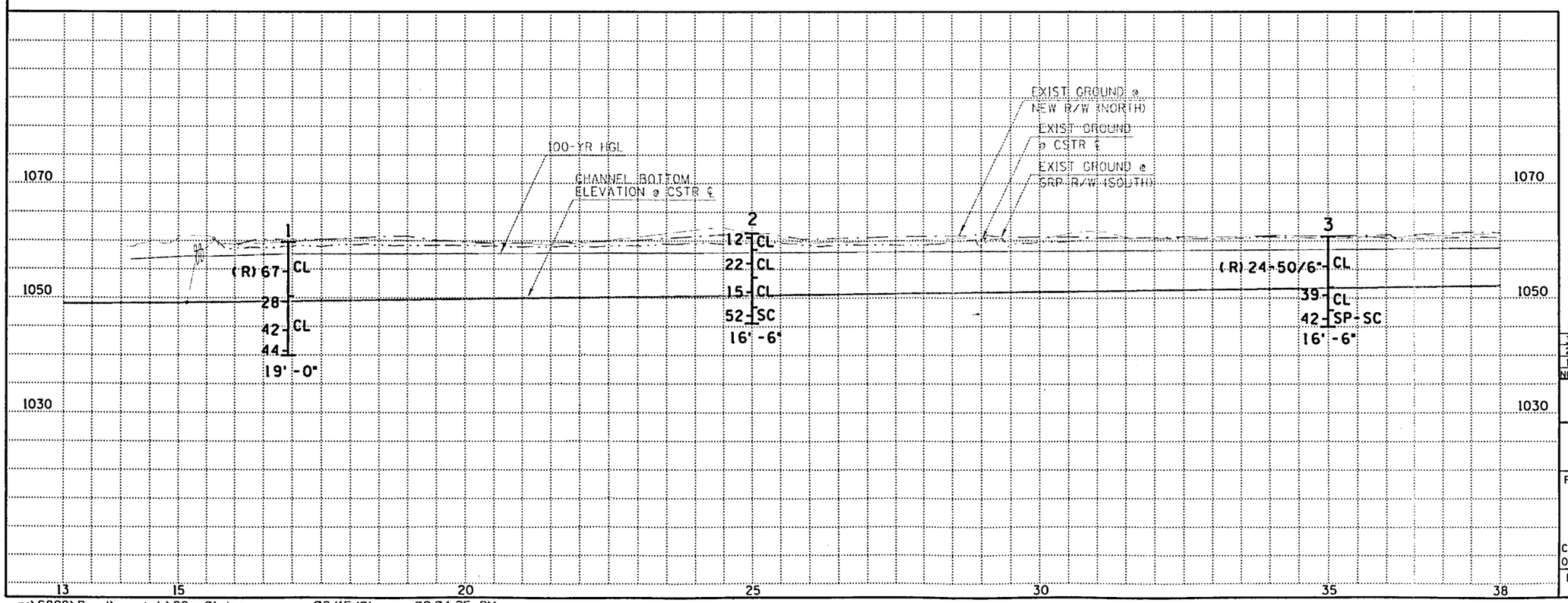
1 (Boring No.)

(Blowcounts, Per Foot) N 30 SM ML (Unified Soil Classification)

Ring Sample (R) 41 CL

TD=36.5' (Total Depth)

1 DMJM Test Boring Location



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FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

BETHANY HOME/GRAND CANAL
FLOOD CONTROL PROJECT
SITE PLAN SHOWING BORING LOCATIONS

PRELIMINARY
30%
Review
NOT FOR CONSTRUCTION OR RECORDING

	BY	DATE
DESIGNED	KHD	8-01
DRAWN	KJM	8-01
CHECKED	MKG	8-01

DMJM+HARRIS
AN AECOM COMPANY
2777 E. CAMELBACK ROAD
SUITE 200
PHOENIX, AZ. 85016-4302
(602) 337-2777

DRAWING NO. Sta 13+00 to Sta 38+00

SHEET 1 OF 5

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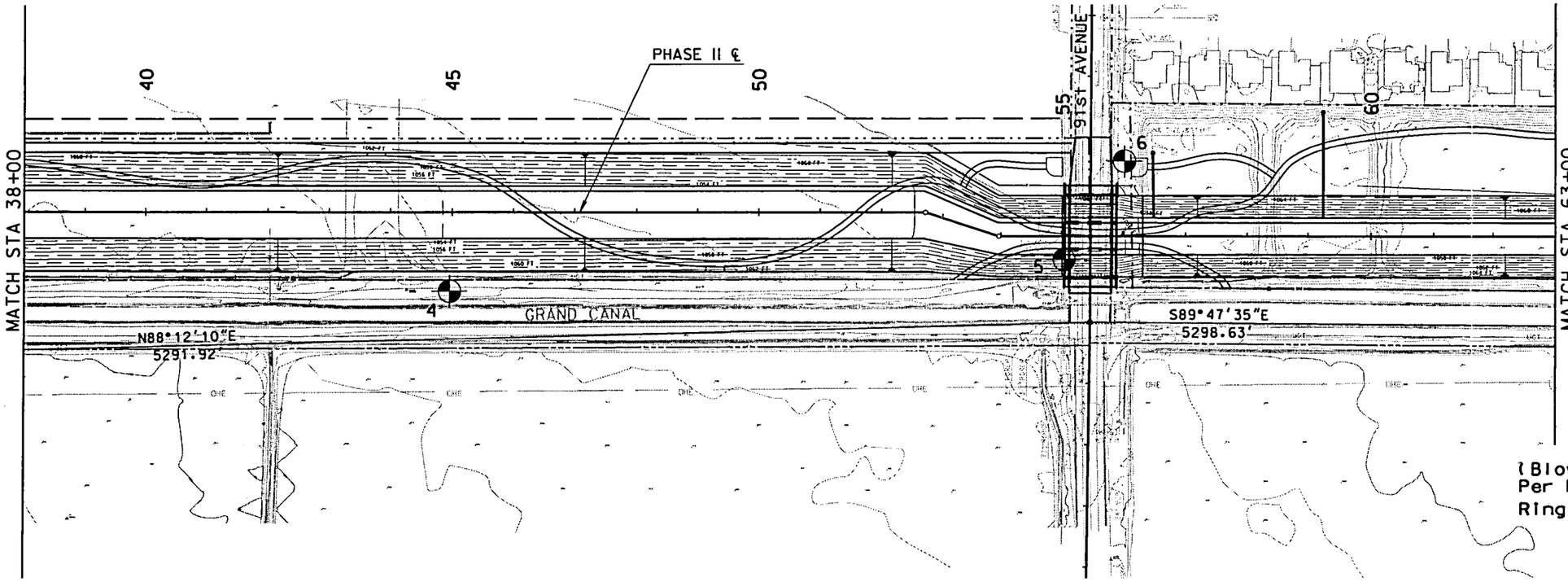

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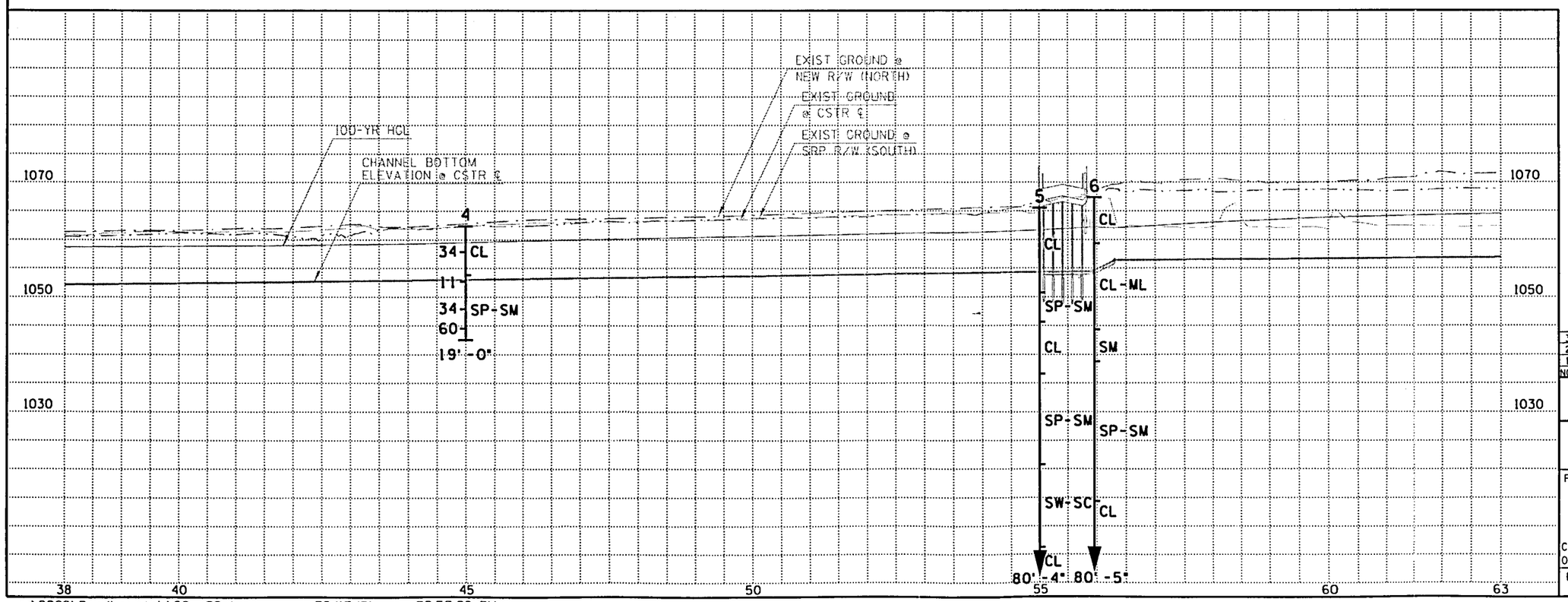
1 (Boring No.)

(Blowcounts, Per Foot) N 30 — SM, ML, CL (Unified Soil Classification)

Ring Sample (R) 41

TD=36.5' (Total Depth)

1 DMJM Test Boring Location



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FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

BETHANY HOME/GRAND CANAL
FLOOD CONTROL PROJECT
SITE PLAN SHOWING BORING LOCATIONS

PRELIMINARY **30%** Review NOT FOR CONSTRUCTION OR RECORDING

	BY	DATE
DESIGNED	KHD	8-01
DRAWN	KJM	8-01
CHECKED	MKG	8-01

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DRAWING NO. Sta 38+00 to Sta 63+00 SHEET 2 OF 5

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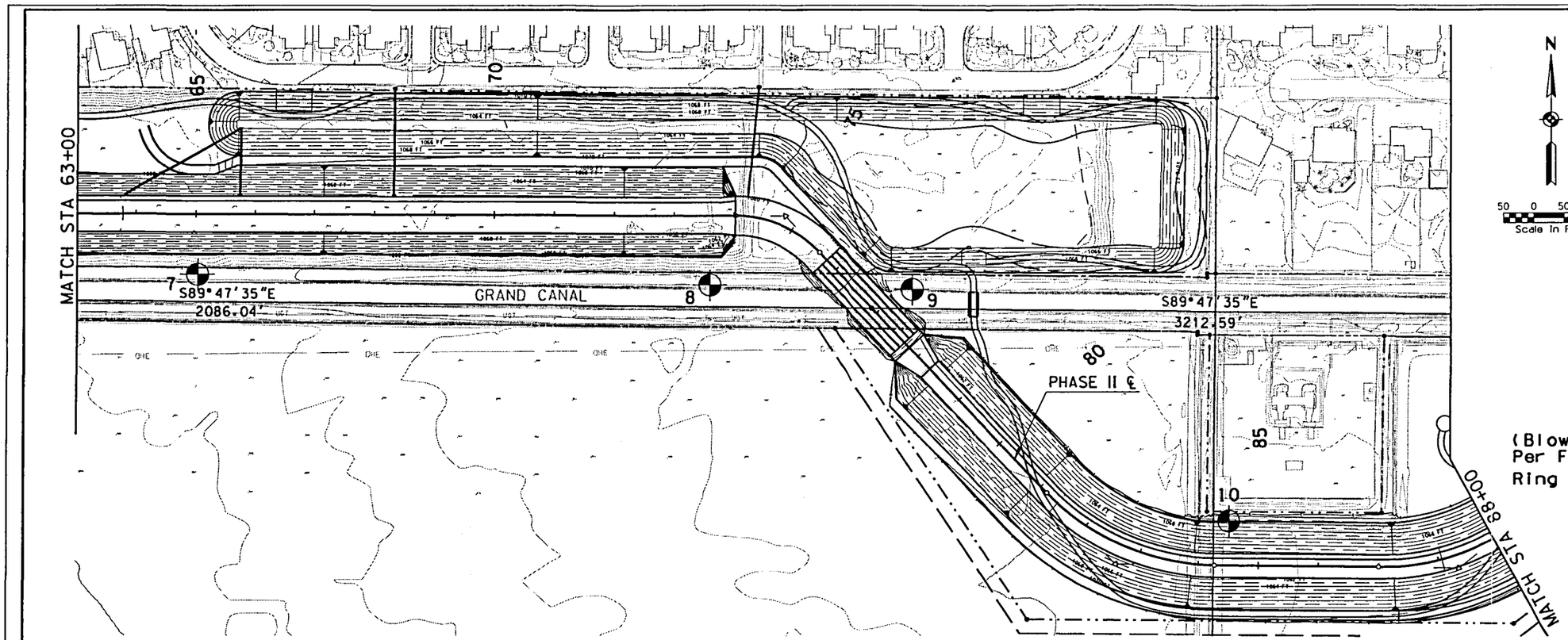


LEGEND

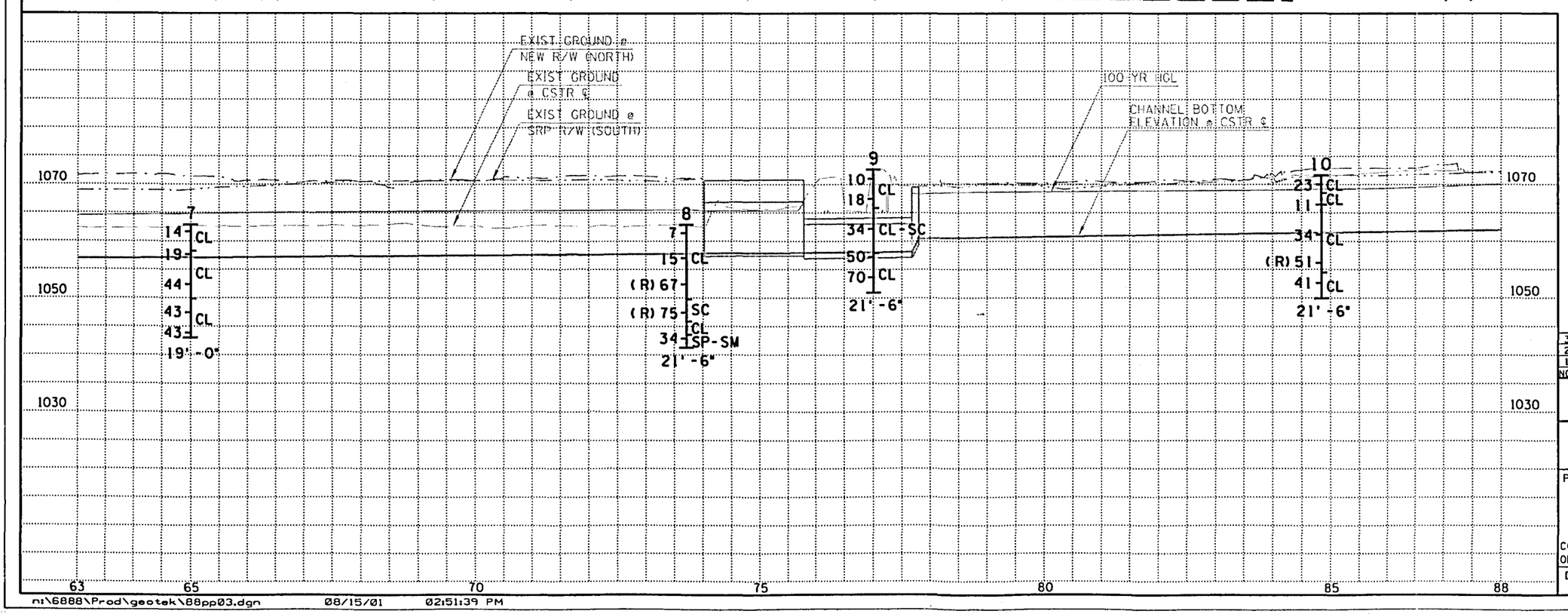
(Boring No.)

(Blowcounts, Per Foot) N 30 — SM, ML (Unified Soil Classification)

Ring Sample (R) 41 — CL

TD=36.5' (Total Depth)

DMJM Test Boring Location



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FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

BETHANY HOME/GRAND CANAL
FLOOD CONTROL PROJECT
SITE PLAN SHOWING BORING LOCATIONS

PRELIMINARY **30%** Review

NOT FOR CONSTRUCTION OR RECORDING

	BY	DATE
DESIGNED	KHD	8-01
DRAWN	KJM	8-01
CHECKED	MKG	8-01

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PHOENIX, AZ. 85016-4302
(602) 337-2777

DRAWING NO. Sta 63+00 to Sta 88+00

SHEET 3 OF 5

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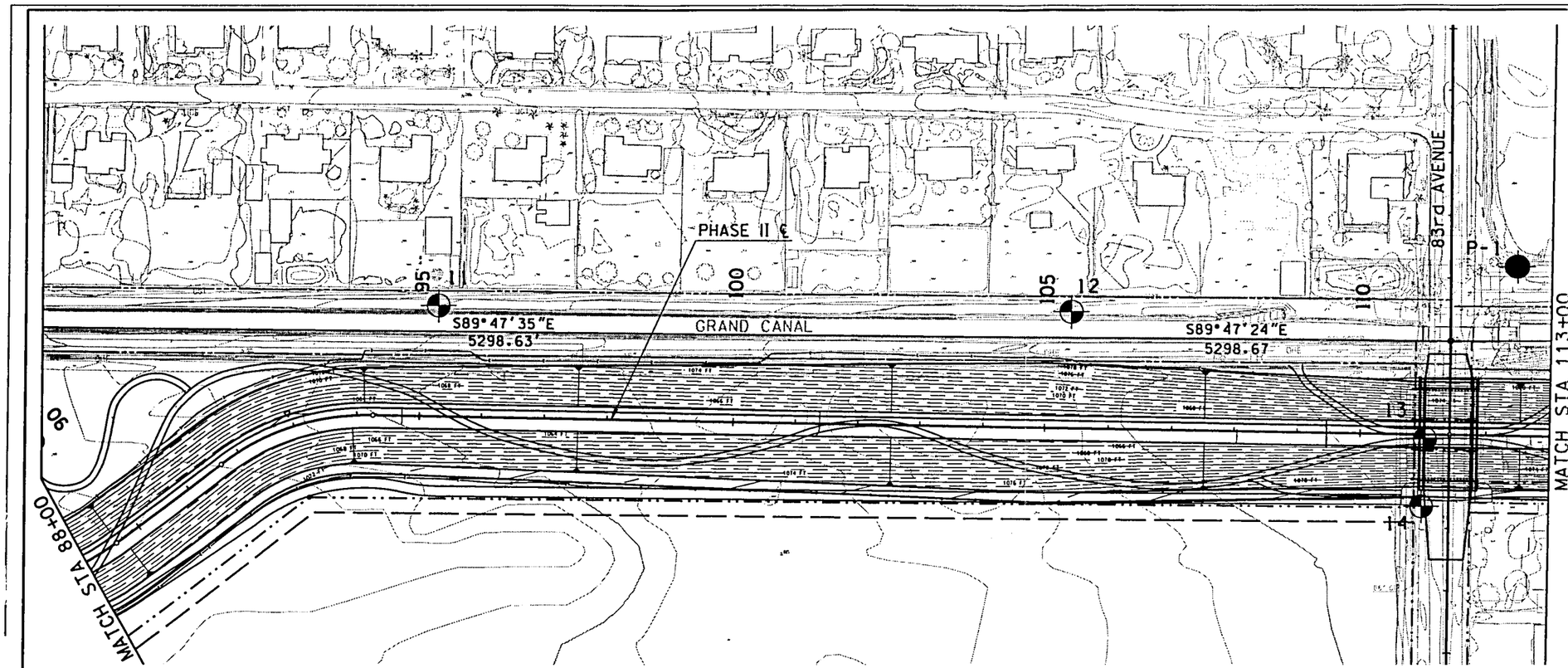
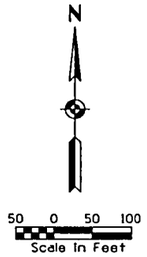




LEGEND

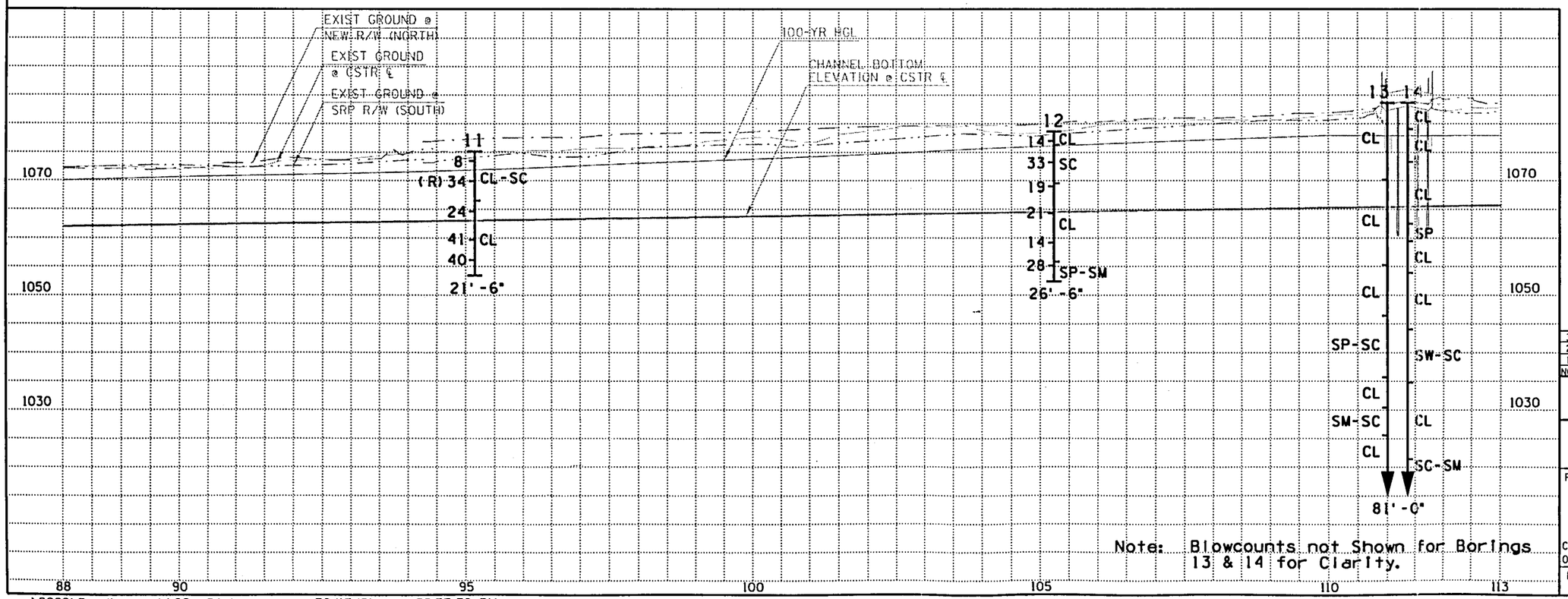
1 (Boring No.)

(Blowcounts, Per Foot) N 30 SM
Ring Sample (R) 41 ML CL (Unified Soil Classification)

TD=36.5' (Total Depth)

1 DMJM Test Boring Location

P-1 ATL Test Boring Location (Preliminary)



Note: Blowcounts not Shown for Borings 13 & 14 for Clarity.

NO.	REVISION	BY	DATE
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FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

BETHANY HOME/GRAND CANAL
FLOOD CONTROL PROJECT
SITE PLAN SHOWING BORING LOCATIONS

PRELIMINARY 30% Review NOT FOR CONSTRUCTION OR RECORDING

	BY	DATE
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DRAWN	KJM	8-01
CHECKED	MKG	8-01

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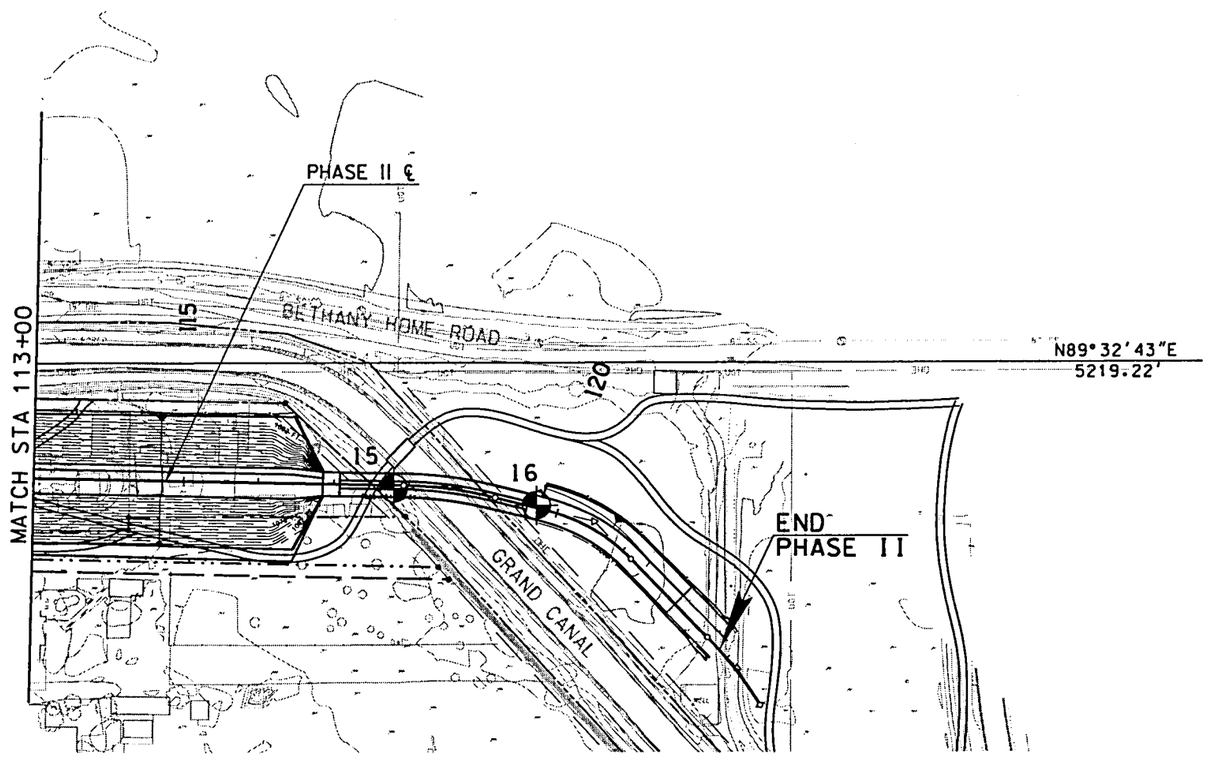

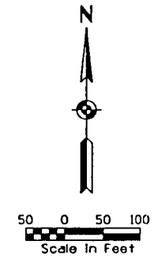

LEGEND

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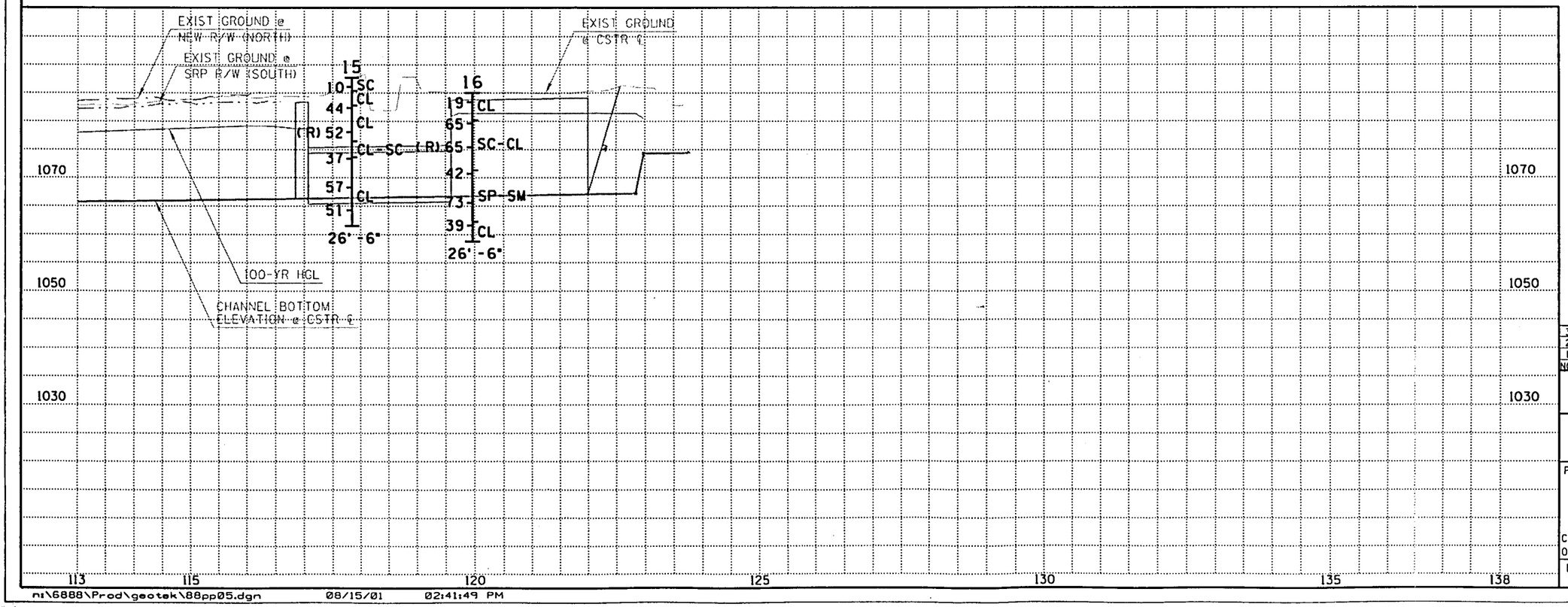
(Blowcounts, Per Foot) N 30 SM ML (Unified Soil Classification)

Ring Sample (R) 41 CL

TD=36.5' (Total Depth)

1 DMJM Test Boring Location



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FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

BETHANY HOME/GRAND CANAL
FLOOD CONTROL PROJECT
SITE PLAN SHOWING BORING LOCATIONS

PRELIMINARY 30% Review NOT FOR CONSTRUCTION OR RECORDING		BY	DATE
	DESIGNED	KHD	8-01
	DRAWN	KJM	8-01
	CHECKED	MKG	8-01

DMJM+HARRIS AN AECOM COMPANY
2777 E. CAMELBACK ROAD SUITE 200 PHOENIX, AZ. 85016-4302 (602) 337-2777

DRAWING NO. Sta 113+00 to Sta 123+76.56 SHEET 5 OF 5

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SAMPLING & BORING LOG INFORMATION

The material and in-situ moisture descriptions presented on the boring logs are based on visual observation and classification in accordance with the Unified Soil Classification System (USCS), presented on the next page. The field logs were modified, where appropriate, based on laboratory testing of selected samples.

The relative density and firmness described on the test boring logs are in general based on standard penetration test (SPT) blows per foot (N) for mostly cohesionless and cohesive soils. 2 inch O.D. SPT samplers are advanced up to 18 inches into undisturbed soils beyond the base of either a hollow stem auger or drill casing. The samplers are driven with a 140 pound hammer and a 30-inch drop. SPT values are recorded on the boring logs for each 6 inch increment of penetration with sampler refusal based on a penetration of less than 6 inches and a blowcount of 50.

Relative Density

Relative density for mostly cohesionless, uncemented sands and sand and gravel mixtures is described based on the following SPT blowcounts:

N	Relative Density
0-4	Very loose
5-10	Loose
11-30	Medium Dense
31-50	Dense
50+	Very Dense

Relative Firmness

Relative Firmness for cohesive and/ or cemented soils including silts, clays and silty to clayey sandy and gravelly soils is described based on the following SPT blowcounts:

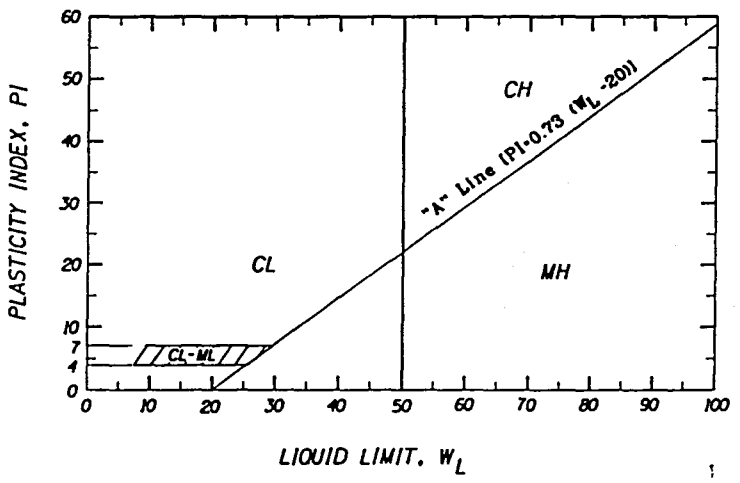
N	Relative Firmness
0-4	Very soft
5-8	Soft
9-15	Moderately firm
16-30	Firm
31-49	Very Firm
50+	Hard

Undisturbed samples of firmer soils, typically present in the southwest, are obtained with 3 inch O.D. samplers lined with 2.42 inch I.D. brass rings. The samplers are advanced up to 12 inches into undisturbed soils beyond the base of either a hollow stem auger or drill casing. The samplers are driven with a 140 pound hammer and a 30-inch drop. The N value blowcounts are recorded on the boring logs for each 6 inch increment of penetration with sampler refusal based on a penetration of less than 12 inches and a blowcount of 100.

UNIFIED SOIL CLASSIFICATION SYSTEM
(ASTM D2487)

Criteria for Assigning Group Symbols and Group Names Using Laboratory Tests				Group Symbol	Graph Symbol	Group Description
Coarse-Grained Soils (More than 50% Retained on No. 200 Sieve).	Gravels More than 50% of Coarse Fraction Retained on No. 200 Sieve.	Clean Gravels (Less than 5% Fines)		GW		Well Graded Gravels, Gravel-Sand Mixtures or Sand-Gravel-Cobble Mixtures.
				GP		Poorly Graded Gravels, Gravel-Sand Mixtures or Sand-Gravel-Cobble Mixtures.
		Gravels with More than 12% Fines	Fines Classify as ML or MH	GM		Silty Gravels, Gravel-Sand-Silt Mixtures.
			Fines Classify as CL or CH	GC		Clayey Gravels, Gravel-Sand-Clay Mixtures.
	Sands 50% or More of Coarse Fraction Passes No. 4 Sieve.	Clean Sands (Less than 5% Fines)		SW		Well Graded Sands, Gravelly Sands.
				SP		Poorly Graded Sands, Gravelly Sands.
		Sands with More than 12% Fines	Fines Classify as ML or MH	SM		Silty Sands, Sand-Silt Mixtures
			Fines Classify as CL or CH	SC		Clayey Sands, Sand-Clay Mixtures.
Fine-Grained Soils (50% or More Passes the No. 200 Sieve).	Silts and Clays (Liquid Limit Less than 50)		PI > 7 and Plots On Above "A" Line	CL		Inorganic Clays of Low to Medium Plasticity, Gravely Clays, Sandy Clays, Silty Clays, Lean Clays
			PI < 4 or Plots Below "A" Line	ML		Inorganic Silts, Clayey Silts with Slight Plasticity
	Silts and Clays (Liquid Limit 50 or More)		PI Plots On or Above "A" Line	CH		Inorganic Clays of High Plasticity, Fat Clays, Silty and Sandy Clays of High Plasticity
			PI Plots Below "A" Line	MH		Inorganic Silts of High Plasticity, Silty Soils, Elastic Silts

PLASTICITY CHART



SOIL PARTICLE DEFINITIONS

MATERIAL	PARTICLE SIZE RANGE
Boulders	Greater than 300mm (12in.)
Cobbles	300mm to 75mm (12in. to 3in.)
Coarse Gravel	75mm to 19mm (3in to 3/4in.)
Fine Gravel	19mm (3/4in.) to No. 4 sieve
Coarse Sand	No. 4 Sieve to No. 10 Sieve
Medium Sand	No. 10 Sieve to No. 40 Sieve
Fine Sand	No. 40 Sieve to No. 200 Sieve
Fines (Silt or Clay)	Less than No. 200 Sieve

Project Name: Bethany Home Outfall Channel
Location: Glendale, AZ
Project Number: 6888.0060
Logged By: C. White

Groundwater		
Depth	Hour	Date
None		

BORING LOG NO. 1
Date(s): 05/30/01
Rig & Boring Type: BK 81 HD/8" HSA
Surface Elevation: 1,061.0' ±
Location: Sta 16+95, 124' Rt

Elev (ft)	Depth (ft)	Penetration Rate (Min./Ft)	Sample Interval	Sample Type & (Blowcounts)	Graphical Log	MATERIAL CLASSIFICATION & USCS	Dry Density (pcf)	Moisture Content (%)
						SANDY CLAY (CL) Fine Grained Sand, Medium Plasticity, Brown, Moist, Medium to Very Firm		
			A					8
						Note: Weakly Lime Cemented & Light Brown Below 3'		
1,056.0	5			R(13-25-42)			112	17
1,051.0	10			S(6-11-17)		SILTY CLAY (CL) Some Fine Grained Sand, Medium Plasticity, Brown, Moist, Firm to Very Firm		
				A				13
1,046.0	15			S(11-27-15)		Note: Considerable Fine to Medium Sand & Some Coarse Gravel 13.5' to 15'		
						Note: Very Moist Below 16'		
				S(10-19-25)		Note: Considerable Sand Below 18'-9"		
1,041.0	20					STOPPED AUGER @ 17'-6" STOPPED SAMPLER @ 19'-0"		
	25							
	30							
	35							
	40							

LABORATORY ANALYSIS

Sample Type
S-Split Spoon
R-Ring Sampler
A-Drill Cuttings

DMJM ARIZONA, INC.
2777 E. CAMELBACK ROAD
SUITE 200
PHOENIX, AZ. 85016-4302
(602) 337-2777

Project Name: Bethany Home Outfall Channel
Location: Glendale, AZ
Project Number: 6888.0060
Logged By: C. White

BORING LOG NO. 2
Date(s): 05/30/01
Rig & Boring Type: BK 81 HD/8" HSA
Surface Elevation: 1,061.0' ±
Location: Sta 24+90, 132' Rt

Groundwater		
Depth	Hour	Date
None		

Elev (ft)	Depth (ft)	Penetration Rate (Min./Ft)	Sample Interval	Sample Type & (Blowcounts)	Graphical Log	MATERIAL CLASSIFICATION & USCS	Laboratory Analysis: Dry Density (pcf)	Laboratory Analysis: Moisture Content (%)
				S(4-6-6)		SANDY CLAY (CL) Fine Grained Sand, Medium Plasticity, Brown, Moist, Moderately Firm		
1,056.0	5			S(6-8-14)		SILTY CLAY (CL) Trace to Some Fine Grained Sand, Some Silt, Medium Plasticity, Light Brown to Brown, Moist to Very Moist, Firm		
1,051.0	10			A S(5-7-8)		SILTY CLAY (CL) Trace of Fine Grained Sand, Medium Plasticity, Brown, Moist, Moderately Firm		19
1,046.0	15			S(16-26-26)		CLAYEY SAND (SC) Trace of Fine Gravel, Well Graded, Medium Plasticity, Brown, Moist, Hard		
1,041.0	20					STOPPED AUGER @ 15'-0" STOPPED SAMPLER @ 16'-6"		
	25							
	30							
	35							
	40							

Sample Type
S-Split Spoon
R-Ring Sampler
A-Drill Cuttings

DMJM ARIZONA, INC.
2777 E. CAMELBACK ROAD
SUITE 200
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Project Name: Bethany Home Outfall Channel
Location: Glendale, AZ
Project Number: 6888.0060
Logged By: C. White

BORING LOG NO. 3
Date(s): 05/30/01
Rig & Boring Type: BK 81 HD/8" HSA
Surface Elevation: 1,061.0' ±
Location: Sta 35+00, 130' Rt

Groundwater		
Depth	Hour	Date
None		

Elev (ft)	Depth (ft)	Penetration Rate (Min./Ft)	Sample Interval	Sample Type & (Blowcounts)	Graphical Log	MATERIAL CLASSIFICATION & USCS	LABORATORY ANALYSIS: Dry Density (pcf)	LABORATORY ANALYSIS: Moisture Content (%)
						SANDY CLAY (CL) Fine Grained Sand, Medium Plasticity, Brown, Moist, Moderately Firm to Hard		
				A				12
1,056.0	5			R(12-24-50/6")		Note: Weak Lime Cement & Light Brown Below 5'	108	18
1,051.0	10			S(8-12-27)		SILTY CLAY (CL) Some Fine Grained Sand, Medium Plasticity, Light Brown, Moist to Very Moist, Very Firm		
1,046.0	15			S(15-19-23)		SAND (SP-SC) Trace to Some Clay, Occassional Gravel, Predominantly Medium to Coarse Grained Sand, Non Plastic to Low Plasticity, Reddish Brown, Moist, Dense		
1,041.0	20					STOPPED AUGER @ 15'-0" STOPPED SAMPLER @ 16'-6"		
	25							
	30							
	35							
	40							

Sample Type
S-Split Spoon
R-Ring Sampler
A-Drill Cuttings

DMJM ARIZONA, INC.
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Project Name: Bethany Home Outfall Channel
Location: Glendale, AZ
Project Number: 6888.0060
Logged By: C. White

Groundwater		
Depth	Hour	Date
None		

BORING LOG NO. 4
Date(s): 05/29/01
Rig & Boring Type: BK 81 HD/8" HSA
Surface Elevation: 1,063.5' ±
Location: Sta 44+95, 130' Rt

Elev (ft)	Depth (ft)	Penetration Rate (Min./Ft)	Sample Interval	Sample Type & (Blowcounts)	Graphical Log	MATERIAL CLASSIFICATION & USCS	Dry Density (pcf)	Moisture Content (%)
			A			SANDY CLAY (CL) Fine Grained Sand, Medium Plasticity, Brown, Moist, Medium to Very Firm		
1,058.5	5			S(8-14-20)		Note: Occassional Zones of Weak Lime Cementation Below 5'		
1,053.5	10			S(4-5-6)		SAND (SP-SM) Trace to Some Silt, Trace of Fine Gravel, Predominantly Medium Grained, Non Plastic, Brown, Medium Dense to Dense, Moist		7
1,048.5	15			S(9-14-20)				
				S(11-30-30)				
1,043.5	20					STOPPED AUGER @ 17'-6" STOPPED SAMPLER @ 19'-0"		
	25							
	30							
	35							
	40							

LABORATORY ANALYSIS

Sample Type
S-Split Spoon
R-Ring Sampler
A-Drill Cuttings

DMJM ARIZONA, INC.
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Project Name: Bethany Home Outfall Channel
Location: Glendale, AZ
Project Number: 6888.0060
Logged By: C. White

BORING LOG NO. 5
Date(s): 05/29/01
Rig & Boring Type: BK 81 HD/8" HSA
Surface Elevation: 1,067.0' ±
Location: Sta 55+08, 38' Rt

Groundwater		
Depth	Hour	Date
None		

Elev (ft)	Depth (ft)	Penetration Rate (Min./Ft)	Sample Interval	Sample Type & (Blowcounts)	Graphical Log	MATERIAL CLASSIFICATION & USCS	Dry Density (pcf)	Moisture Content (%)
						SANDY CLAY (CL) Some Silt, Fine Grained Sand, Medium Plasticity, Brown, Moist, Soft to Hard		
1,062.0	5			R(8-11-11)		Note: Weakly Lime Cemented Below 5'	104	13
		A						10
1,057.0	10			S(19-42-50)				
				A				
1,052.0	15			R(18-28-35)		SAND (SP-SM) Some Silt, Trace of Fine Subround Gravel, Predominantly Medium Grained Subangular Sand, Brown, Dense, Slightly Moist to Moist		3
1,047.0	20			S(20-40-50/6")		SANDY CLAY (CL) Fine Grained Sand, Medium Plasticity, Weakly Lime Cemented, Brown to Light Brown, Moist to Very Moist, Hard		
1,042.0	25			S(18-35-39)		Note: 1½" Thick Lens of Strong Lime Cementation, Interbedded with Thin Lenses of Fine Sand & Silty Clay		
1,037.0	30			S(18-26-30)		SAND (SP-SM) Some Fine Subangular to Subround Gravel, Some Silt Predominantly Medium to Coarse Subangular Sand, Grayish Brown, Slightly Moist to Moist, Dense		
1,032.0	35			S(11-30-40)		Note: Some Subround Coarse Gravel Below 38'		6
1,027.0	40							

Sample Type
S-Split Spoon
R-Ring Sampler
A-Drill Cuttings

DMJM ARIZONA, INC.
2777 E. CAMELBACK ROAD
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Project Name: Bethany Home Outfall Channel
Location: Glendale, AZ
Project Number: 6888.0060
Logged By: C. White

BORING LOG NO. 5
Date(s): 05/29/01
Rig & Boring Type: BK 81 HD/8" HSA
Surface Elevation: 1,067.0' ±
Location: Sta 55+08, 38' Rt

Groundwater		
Depth	Hour	Date
None		

Elev (ft)	Depth (ft)	Penetration Rate (Min./Ft)	Sample Interval	Sample Type & (Blowcounts)	Graphical Log	MATERIAL CLASSIFICATION & USCS	Dry Density (pcf)	Moisture Content (%)
				S(50/2")		SAND (SP-SM) Cont'd...		
1,022.0	45			S(50/6")		SAND (SW-SC) Trace to Considerable Poorly Graded Subround to Subrounded Gravel, Trace to Some Clay, Predominantly Medium to Coarse Sand, Non Plastic to Low Plasticity, Grayish Brown to Reddish Brown, Moist, Dense		
1,017.0	50			S(40-25-50/5")		Note: Interbedded with Very Dense Gravelly Lenses & Some Small Cobbles		
1,012.0	55			S(40-50/5")				
1,007.0	60			S(16-19-20)		SANDY CLAY (CL) Fine Sand, Trace of Silt, Medium Plasticity, Brown, Moist to Very Moist, Very Firm to Hard		
1,002.0	65			S(43-50/3")		Note: Weak Lime Cement Below 64'		
997.0	70			S(17-25-32)		SILTY TO CLAYEY SAND (SM-SC) Fine Grained Sand, Low Plasticity, Brown, Very Moist to Wet, Hard		
992.0	75			S(20-25-39)		CLAYEY SAND (SC) Trace of Fine Gravel, Predominantly Medium Grained, Medium Plasticity, Brown to Reddish Brown, Moist, Hard		
987.0	80							

Sample Type
S-Split Spoon
R-Ring Sampler
A-Drill Cuttings

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Project Name: Bethany Home Outfall Channel
Location: Glendale, AZ
Project Number: 6888.0060
Logged By: C. White

BORING LOG NO. 5
Date(s): 05/29/01
Rig & Boring Type: BK 81 HD/8" HSA
Surface Elevation: 1,067.0' ±
Location: Sta 55+08, 38' Rt

Groundwater		
Depth	Hour	Date
None		

Elev (ft)	Depth (ft)	Penetration Rate (Min./Ft)	Sample Interval	Sample Type & (Blowcounts)	Graphical Log	MATERIAL CLASSIFICATION & USCS	LABORATORY ANALYSIS: Dry Density (pcf)	LABORATORY ANALYSIS: Moisture Content (%)
				S(50/4")		CLAYEY SAND (SC) Cont'd...		
						STOPPED AUGER @ 80'-0" SAMPLER REFUSED @ 80'-4"		
982.0	85							
	90							
	95							
	100							
	105							
	110							
	115							
	120							

Sample Type
S-Split Spoon
R-Ring Sampler
A-Drill Cuttings

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Project Name: Bethany Home Outfall Channel
Location: Glendale, AZ
Project Number: 6888.0060
Logged By: C. White

BORING LOG NO. 6
Date(s): 05/29/01
Rig & Boring Type: BK 81 HD/8" HSA
Surface Elevation: 1,065.0' ±
Location: Sta 56+05, 122' Lt

Groundwater		
Depth	Hour	Date
None		

Elev (ft)	Depth (ft)	Penetration Rate (Min./Ft)	Sample Interval	Sample Type & (Blowcounts)	Graphical Log	MATERIAL CLASSIFICATION & USCS	Laboratory Analysis: Dry Density (pcf)	Laboratory Analysis: Moisture Content (%)
				A		SANDY CLAY (CL) Some Silt, Fine Grained Sand, Medium Plasticity, Light Brown, Slightly Moist, Moderately Firm to Very Firm		
1,060.0	5			S(10-19-19)		Note: Weakly Lime Cemented Below 4'		
1,055.0	10			R(25-50/6")		SANDY CLAY (CL-ML) Some Silt, Fine Grained Sand, Low to Medium Plasticity, Brown, Moist, Firm to Hard		16
1,050.0	15			S(11-17-20)		Note: Considerable Silt @ 15' Note: Increase in Fine Sand Below 20'		
1,045.0	20			S(15-20-36)				
1,040.0	25			R(39-50/6") A		SILTY SAND (SM) Fine Grained, Non Plastic to Low Plasticity, Brown, Moist to Very Moist, Dense to Hard		7
1,035.0	30			S(18-50/6")		SAND (SP-SM) Some Fine Subround Gravel, Trace to Some Silt, Predominantly Fine to Medium Grained, Non Plastic, Brown to Grayish Brown, Moist, Dense		
1,030.0	35			S(50/2")		Note: Considerable Poorly Graded Gravel from 32'-39'		
1,025.0	40							

Sample Type
S-Split Spoon
R-Ring Sampler
A-Drill Cuttings

DMJM ARIZONA, INC.
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(602) 337-2777

Project Name: Bethany Home Outfall Channel
Location: Glendale, AZ
Project Number: 6888.0060
Logged By: C. White

BORING LOG NO. 6
Date(s): 05/29/01
Rig & Boring Type: BK 81 HD/8" HSA
Surface Elevation: 1,065.0' ±
Location: Sta 56+05, 122' Lt

Groundwater		
Depth	Hour	Date
None		

Elev (ft)	Depth (ft)	Penetration Rate (Min./Ft)	Sample Interval	Sample Type & (Blowcounts)	Graphical Log	MATERIAL CLASSIFICATION & USCS	LABORATORY ANALYSIS: Dry Density (pcf)	LABORATORY ANALYSIS: Moisture Content (%)
				S(14-24-33)		SAND (SP-SM) Cont'd...		4
1,020.0	45			S(24-50/6")		Note: Some Medium Grained Sand Lenses Note: Considerable Gravel & Possible Cobble from 47.5'-50'		
1,015.0	50			S(15-50/5")				
1,010.0	55			S(16-50/5½")		SANDY CLAY (CL) Some Silt, Fine Grained Sand, Weak Lime Cementation, Low to Medium Plasticity, Brown, Moist to Very Moist, Hard		
1,005.0	60			S(14-44-45)		CLAYEY SAND (SC-SM) Predominantly Fine Grained Sand, Low to Medium Plasticity, Brown, Moist to Very Moist, Hard		33
1,000.0	65			S(39-50/5")				
995.0	70			S(30-50/6")		SAND (SP-SC) Some Fine Gravel, Trace of Clay, Predominantly Medium Grained Sand, Non Plastic to Low Plasticity, Grayish Brown, Moist, Dense to Very Dense		5
990.0	75			S(50/3")		Note: Some to Considerable Poorly Graded Gravel & Occassional Cobbles from 72'-74'		
985.0	80							

Sample Type
S-Split Spoon
R-Ring Sampler
A-Drill Cuttings

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Project Name: Bethany Home Outfall Channel
Location: Glendale, AZ
Project Number: 6888.0060
Logged By: C. White

BORING LOG NO. 6
Date(s): 05/29/01
Rig & Boring Type: BK 81 HD/8" HSA
Surface Elevation: 1,065.0' ±
Location: Sta 56+05, 122' Lt

Groundwater		
Depth	Hour	Date
None		

Elev (ft)	Depth (ft)	Penetration Rate (Min./Ft)	Sample Interval	Sample Type & (Blowcounts)	Graphical Log	MATERIAL CLASSIFICATION & USCS	LABORATORY ANALYSIS: Dry Density (pcf)	LABORATORY ANALYSIS: Moisture Content (%)
				S(50/5")		SAND (SP-SC) Cont'd...		
						STOPPED AUGER @ 80'-0" SAMPLER REFUSED @ 80'-5"		
980.0	85							
	90							
	95							
	100							
	105							
	110							
	115							
	120							

Sample Type
S-Split Spoon
R-Ring Sampler
A-Drill Cuttings

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Project Name: Bethany Home Outfall Channel
Location: Glendale, AZ
Project Number: 6888.0060
Logged By: C. White

BORING LOG NO. 7
Date(s): 05/30/01
Rig & Boring Type: BK 81 HD/8" HSA
Surface Elevation: 1,070.0' ±
Location: Sta 65+00, 100' Rt

Groundwater		
Depth	Hour	Date
None		

Elev (ft)	Depth (ft)	Penetration Rate (Min./Ft)	Sample Interval	Sample Type & (Blowcounts)	Graphical Log	MATERIAL CLASSIFICATION & USCS	Laboratory Analysis: Dry Density (pcf)	Laboratory Analysis: Moisture Content (%)
				S(7-7-7)		SANDY CLAY (CL) Fine Grained Sand, Medium Plasticity, Light Brown, Moist, Moderately Firm Note: Embankment Fill		
						SILTY CLAY (CL) Some Fine Grained Sand, Medium Plasticity, Dark Brown, Very Moist, Moderately Firm		
1,065.0	5			S(4-10-9)		SANDY CLAY (CL) Fine Grained Sand, Weak Lime Cementation, Medium Plasticity, Light Brown, Slightly Moist to Moist, Firm to Very Firm		
				A				15
1,060.0	10			S(14-18-36)		Note: Moist Below 8'		
1,055.0	15			S(15-18-25)		SILTY CLAY (CL) Some Fine Grained Sand, Medium Plasticity, Brown, Moist to Very Moist, Very Firm		
				S(14-18-25)				
1,050.0	20					STOPPED AUGER @ 17'-6" STOPPED SAMPLER @ 19'-0"		
	25							
	30							
	35							
	40							

Sample Type
S-Split Spoon
R-Ring Sampler
A-Drill Cuttings

DMJM ARIZONA, INC.
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Project Name: Bethany Home Outfall Channel
Location: Glendale, AZ
Project Number: 6888.0060
Logged By: C. White

BORING LOG NO. 8
Date(s): 05/30/01
Rig & Boring Type: BK 81 HD/8" HSA
Surface Elevation: 1,072.0' ±
Location: Sta 73+57, 115' Rt

Groundwater		
Depth	Hour	Date
None		

Elev (ft)	Depth (ft)	Penetration Rate (Min./Ft)	Sample Interval	Sample Type & (Blowcounts)	Graphical Log	MATERIAL CLASSIFICATION & USCS	Laboratory Analysis: Dry Density (pcf)	Laboratory Analysis: Moisture Content (%)
				S(5-4-3)		SANDY CLAY (CL) Fine Grained Sand, Medium Plasticity, Brown, Moist, Soft to Hard Note: Embankment Fill from 0'-1' Note: More Fine & Medium Sand Below 10'		
1,065.0	5			S(7-7-8)				11
			A					
1,060.0	10			R(17-50/6")				
						CLAYEY SAND (SC) Medium Grained Sand, Medium Plasticity, Brown, Moist, Very Firm to Hard		
1,055.0	15			R(25-50/6")				
						SILTY CLAY (CL) Some Fine Grained Sand, Medium Plasticity, Dark Brown, Very Moist, Firm		
1,050.0	20			S(12-16-18)		SAND (SP-SM) Trace of Silt, Trace of Fine Subangular Gravel, Predominantly Fine & Medium Grained Sand, Non Plastic, Grayish Brown, Slightly Moist, Dense STOPPED AUGER @ 20'-0" STOPPED SAMPLER @ 21'-6"		
1,045.0	25							
	30							
	35							
	40							

Sample Type
S-Split Spoon
R-Ring Sampler
A-Drill Cuttings

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SUITE 200
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Project Name: Bethany Home Outfall Channel
Location: Glendale, AZ
Project Number: 6888.0060
Logged By: C. White

BORING LOG NO. 9
Date(s): 05/30/01
Rig & Boring Type: BK 81 HD/8" HSA
Surface Elevation: 1,072.0' ±
Location: Sta 77+15, 70'Lt

Groundwater		
Depth	Hour	Date
None		

Elev (ft)	Depth (ft)	Penetration Rate (Min./Ft)	Sample Interval	Sample Type & (Blowcounts)	Graphical Log	MATERIAL CLASSIFICATION & USCS	LABORATORY ANALYSIS: Dry Density (pcf)	LABORATORY ANALYSIS: Moisture Content (%)
				S(6-6-4)		SANDY CLAY (CL) Some Silt, Fine Grained Sand, Medium Plasticity, Light Brown to Brown, Moist, Moderately Firm to Firm		
				A				12
1,067.0	5	A		S(6-7-11)				
1,062.0	10			R(11-15-19)		CLAY & SAND (CL-SC) Fine Grained Sand, Low to Medium Plasticity, Light Brown, Moist, Firm	107	13
1,057.0	15			S(17-24-26)		SILTY CLAY (CL) Some Fine Grained Sand, Medium Plasticity, Brown, Very Moist, Very Firm to Hard		
1,052.0	20			R(17-27-43)				
1,047.0	25					STOPPED AUGER @ 20'-0" STOPPED SAMPLER @ 21'-6"		
	30							
	35							
	40							

Sample Type
S-Split Spoon
R-Ring Sampler
A-Drill Cuttings

DMJM ARIZONA, INC.
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SUITE 200
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Project Name: Bethany Home Outfall Channel
Location: Glendale, AZ
Project Number: 6888.0060
Logged By: C. White

Groundwater		
Depth	Hour	Date
None		

BORING LOG NO. 10
Date(s): 05/30/01
Rig & Boring Type: BK 81 HD/8" HSA
Surface Elevation: 1,072.5' ±
Location: Sta 84+50, 75' Lt

Elev (ft)	Depth (ft)	Penetration Rate (Min./Ft)	Sample Interval	Sample Type & (Blowcounts)	Graphical Log	MATERIAL CLASSIFICATION & USCS	Dry Density (pcf)	Moisture Content (%)
				S(11-9-14)		SANDY CLAY (CL) Fine Grained Sand, Medium Plasticity, Light Brown, Slightly Moist, Moderately Firm to Firm		
						SILTY CLAY (CL) Some Fine Grained Sand, Medium to High Plasticity, Brown, Moist, Moderately Firm		15
1,067.5	5	A		S(3-4-7)		SANDY CLAY (CL) Fine Grained Sand, Some Silt, Medium Plasticity, Light Brown to Brown, Moist, Medium Firm to Very Firm		
1,062.5	10			S(8-12-22)				
1,057.5	15			R(8-18-33)			107	20
		A				CLAY (CL) Trace to Some Fine Sand, Trace of Silt, Medium to High Plasticity, Brown, Moist to Very Moist, Very Firm		19
1,052.5	20			S(7-17-24)				
						STOPPED AUGER @ 20'-0" STOPPED SAMPLER @ 21'-6"		
1,047.5	25							
	30							
	35							
	40							

LABORATORY ANALYSIS

Sample Type
S-Split Spoon
R-Ring Sampler
A-Drill Cuttings

DMJM ARIZONA, INC.
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Project Name: Bethany Home Outfall Channel
Location: Glendale, AZ
Project Number: 6888.0060
Logged By: C. White

BORING LOG NO. 11
Date(s): 05/30/01
Rig & Boring Type: BK 81 HD/8" HSA
Surface Elevation: 1,075.0' ±
Location: Sta 95+30, 177' Lt

Groundwater		
Depth	Hour	Date
None		

Elev (ft)	Depth (ft)	Penetration Rate (Min./Ft)	Sample Interval	Sample Type & (Blowcounts)	Graphical Log	MATERIAL CLASSIFICATION & USCS	LABORATORY ANALYSIS: Dry Density (pcf)	LABORATORY ANALYSIS: Moisture Content (%)
				S(4-4-4)		SANDY CLAY TO CLAYEY SAND (CL-SC) Fine Sand, Medium Plasticity, Light Brown to Brown, Moist, Moderately Firm to Very Firm		
		A						11
1,070.0	5			R(5-19-15)		Note: Occassional Fine Gravel Below 4'		
1,065.0	10			S(4-8-16)		SILTY CLAY (CL) Trace to Some Fine Sand, Medium Plasticity, Brown, Moist, Firm to Very Firm		
1,060.0	15			S(14-20-21)				
1,055.0	20			S(14-18-22)				
1,050.0	25					STOPPED AUGER @ 20'-0" STOPPED SAMPLER @ 21-6"		
	30							
	35							
	40							

Sample Type
S-Split Spoon
R-Ring Sampler
A-Drill Cuttings

DMJM ARIZONA, INC.
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SUITE 200
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Project Name: Bethany Home Outfall Channel
Location: Glendale, AZ
Project Number: 6888.0060
Logged By: C. White

BORING LOG NO. 12
Date(s): 05/30/01
Rig & Boring Type: BK 81 HD/8" HSA
Surface Elevation: 1,079.0'±
Location: Sta 105+40, 185'Lt

Groundwater		
Depth	Hour	Date
None		

Elev (ft)	Depth (ft)	Penetration Rate (Min./Ft)	Sample Interval	Sample Type & (Blowcounts)	Graphical Log	MATERIAL CLASSIFICATION & USCS	Dry Density (pcf)	Moisture Content (%)
				S(9-7-7)		SANDY CLAY (CL) Fine Sand, Low to Medium Plasticity, Light Brown, Slightly Moist, Moderately Firm Note: Embankment Fill		
1,074.0	5	A		S(8-12-21)		CLAYEY SAND (SC) Fine Grained Sand, Low to Medium Plasticity, Light Brown, Moist, Firm Note: Increase In Well Graded Sand with a Trace of Gravel from 4.5'-9'		7
1,069.0	10			S(7-9-10)		SILTY CLAY (CL) Some Fine Sand, Medium Plasticity, Brown, Moist to Very Moist, Firm		
1,064.0	15			S(7-9-12)				
1,059.0	20	A		S(7-7-7)				
1,054.0	25			S(10-12-16)		SAND (SP-SM) Trace to Some Silt, Trace of Fine Gravel, Predominantly Fine to Medium Sand, Non Plastic, Brown, Moist, Medium Dense		
1,049.0	30					STOPPED AUGER @ 25'-0" STOPPED SAMPLER @ 26'-6"		
	35							
	40							

Sample Type
S-Split Spoon
R-Ring Sampler
A-Drill Cuttings

DMJM ARIZONA, INC.
2777 E. CAMELBACK ROAD
SUITE 200
PHOENIX, AZ. 85016-4302
(602) 337-2777

Project Name: Bethany Home Outfall Channel
Location: Glendale, AZ
Project Number: 6888.0060
Logged By: C. White

Groundwater		
Depth	Hour	Date
None		

BORING LOG NO. 13
Date(s): 06/06/01
Rig & Boring Type: BK 81 HD/8" HSA
Surface Elevation: 1,082.0' ±
Location: Sta 111+05, 10' Rt

Elev (ft)	Depth (ft)	Penetration Rate (Min./Ft)	Sample Interval	Sample Type & (Blowcounts)	Graphical Log	MATERIAL CLASSIFICATION & USCS	LABORATORY ANALYSIS Dry Density (pcf)	LABORATORY ANALYSIS Moisture Content (%)
						Asphaltic Concrete (AC) 0-4" over Aggregate Base Course (ABC) 4"-22"		
1,077.0	5			S(3-3-6)		SILTY CLAY (CL) Trace to Some Fine Sand, Medium Plasticity, Brown, Moist, Moderately Firm. Note: Interbedded Sandy Lenses Below 4'		
1,072.0	10			S(7-8-6)				
1,067.0	15			R(21)		SILTY CLAY (CL) Trace of Fine Sand, Medium Plasticity, Brown, Very Moist. Note: Some to Considerable Medium Grained Sand 18'-23'	103	15
1,062.0	20			A R(19)			108	15
1,057.0	25			S(7-11-15)				
1,052.0	30			R(78/11")		SANDY CLAY (CL) Some Fine Grained Sand, Weakly Lime Cemented, Medium Plasticity, Medium Brown to Light Brown, Moist, Hard. Note: Considerable Silt @ 35'	103	13
1,047.0	35			S(30-45-35)				
1,042.0	40					SAND (SP-SM) Trace of Clay, Predominantly Medium Sand, Non Plastic, Brown, Moist, Medium Dense		

Sample Type
S-Split Spoon
R-Ring Sampler
A-Drill Cuttings

DMJM ARIZONA, INC.
2777 E. CAMELBACK ROAD
SUITE 200
PHOENIX, AZ. 85016-4302
(602) 337-2777

Project Name: Bethany Home Outfall Channel
Location: Glendale, AZ
Project Number: 6888.0060
Logged By: C. White

Groundwater		
Depth	Hour	Date
None		

BORING LOG NO. 13
Date(s): 06/06/01
Rig & Boring Type: BK 81 HD/8" HSA
Surface Elevation: 1,082.0' ±
Location: Sta 111+05, 10' Rt

Elev (ft)	Depth (ft)	Penetration Rate (Min./Ft)	Sample Interval	Sample Type & (Blowcounts)	Graphical Log	MATERIAL CLASSIFICATION & USCS	Dry Density (pcf)	Moisture Content (%)
				S(9-17-24)		SAND (SP-SM) Cont'd... Note: Trace to Some Subangular Poorly Graded Gravel Below 40', Interbedded with Lenses of Subangular Clean Sand		
1,037.0	45			S(11-17-16)				
1,032.0	50			S(26-20-7)		SANDY CLAY (CL) Some Silt, Fine Grained Sand, Weak Lime Cementation, Medium Plasticity, Tan, Slightly Moist, Hard. Note: No Lime Cement, Moist, Moderately Firm Below 51'		
1,027.0	55			S(4-4-10)		SILTY TO CLAYEY SAND (SM-SC) Fine Grained, Low Plasticity, Brown, Very Moist, Moderately Firm		
1,022.0	60			S(7-9-14)		SILTY CLAY (CL) Trace to Some Fine Grained Sand, Medium Plasticity, Brown (Tan Cemented Layers), Moist to Very Moist, Firm. Note: Occassional Thin Beds (1/4" to 3" Thick) of Weak to Moderate Lime Cement		
1,017.0	65			S(7-10-12)		Note: Lens of Medium Grained Sand @ 66'		
1,012.0	70			S(7-13-15)				
1,007.0	75			S(7-19-20)				
1,002.0	80							

Sample Type
S-Split Spoon
R-Ring Sampler
A-Drill Cuttings

DMJM ARIZONA, INC.
2777 E. CAMELBACK ROAD
SUITE 200
PHOENIX, AZ. 85016-4302
(602) 337-2777

Project Name: Bethany Home Outfall Channel
Location: Glendale, AZ
Project Number: 6888.0060
Logged By: C. White

Groundwater		
Depth	Hour	Date
None		

BORING LOG NO. 13
Date(s): 06/06/01
Rig & Boring Type: BK 81 HD/8" HSA
Surface Elevation: 1,082.0' ±
Location: Sta 111+05, 10' Rt

Elev (ft)	Depth (ft)	Penetration Rate (Min./Ft)	Sample Interval	Sample Type & (Blowcounts)	Graphical Log	MATERIAL CLASSIFICATION & USCS	LABORATORY ANALYSIS: Dry Density (pcf)	LABORATORY ANALYSIS: Moisture Content (%)
				S(21-50/6")		SILTY CLAY (CL) Cont'd...		
						STOPPED AUGER @ 80'-0" SAMPLER REFUSED @ 81'-0"		
997.0	85							
	90							
	95							
	100							
	105							
	110							
	115							
	120							

Sample Type
S-Split Spoon
R-Ring Sampler
A-Drill Cuttings

DMJM ARIZONA, INC.
2777 E. CAMELBACK ROAD
SUITE 200
PHOENIX, AZ. 85016-4302
(602) 337-2777

Project Name: Bethany Home Outfall Channel
Location: Glendale, AZ
Project Number: 6888.0060
Logged By: C. White

Groundwater		
Depth	Hour	Date
None		

BORING LOG NO. 14
Date(s): 06/06/01
Rig & Boring Type: BK 81 HD/8" HSA
Surface Elevation: 1,081.8' ±
Location: Sta 110+98, 120' Rt

Elev (ft)	Depth (ft)	Penetration Rate (Min./Ft)	Sample Interval	Sample Type & (Blowcounts)	Graphical Log	MATERIAL CLASSIFICATION & USCS	Dry Density (pcf)	Moisture Content (%)
						Asphaltic Concrete (AC) 0-4" over Aggregate Base Course (ABC) 4"-22"		
						SILTY CLAY (CL) Some Fine Grained Sand, Medium Plasticity, Brown, Moist, Firm		
1,076.8	5	A		S(4-9-12)		CLAYEY SAND (SC) Fine to Medium Grained Sand, Medium Plasticity, Light Brown, Moist, Firm		
1,071.8	10			R(27)		SILTY CLAY (CL) Trace to Some Fine Sand, Medium Plasticity, Brown, Moist, Firm to Very Firm	98	13
1,066.8	15			S(8-14-20)				
1,061.8	20			S(5-11-20)				
						SAND (SP) Some Fine Subrounded Gravel, Predominantly Medium to Coarse Subangular Sand, Non Plastic, Grayish Brown, Very Moist, Medium Dense		
1,056.8	25			S(7-14-19)		SILTY CLAY (CL) Trace of Fine Sand, Medium Plasticity, Brown, Moist to Very Moist, Very Firm		
1,051.8	30			S(20-43-50/5")		SANDY CLAY (CL) Some Silt, Fine Grained Sand, Weak Lime Cementation, Medium Plasticity, Light Brown, Moist, Hard Note: Slightly Moist from 33'-37'		
1,046.8	35			S(50/5½")				
						SAND (SW-SC) Some to Considerable Predominantly Fine Subround Gravel, Subangular to Subround Sand, Non Plastic, Brown, Moist, Dense		
1,041.8	40							

Sample Type
S-Split Spoon
R-Ring Sampler
A-Drill Cuttings

DMJM ARIZONA, INC.
2777 E. CAMELBACK ROAD
SUITE 200
PHOENIX, AZ. 85016-4302
(602) 337-2777

Project Name: Bethany Home Outfall Channel
Location: Glendale, AZ
Project Number: 6888.0060
Logged By: C. White

BORING LOG NO. 14
Date(s): 06/06/01
Rig & Boring Type: BK 81 HD/8" HSA
Surface Elevation: 1,081.8' ±
Location: Sta 110+98, 120' Rt

Groundwater		
Depth	Hour	Date
None		

Elev (ft)	Depth (ft)	Penetration Rate (Min./Ft)	Sample Interval	Sample Type & (Blowcounts)	Graphical Log	MATERIAL CLASSIFICATION & USCS	LABORATORY ANALYSIS: Dry Density (pcf)	LABORATORY ANALYSIS: Moisture Content (%)
				S(12-20-21)		SAND (SW-SC) Cont'd...		
						Note: Occassional Thin Lenses of Sandy Clay		
1,036.8	45			S(12-15-18)				
1,031.8	50			S(5-12-21)		SILTY CLAY (CL) Trace to Some Fine Grained Sand, Medium Plasticity, Brown, Very Moist, Firm to Medium Firm		
						Note: Considerable Fine Sand @ 50.5'-51.5'		
1,026.8	55			S(3-4-9)		Note: Wet to Very Moist from 50'-56'		
1,021.8	60			R(45)			77	42
1,016.8	65			S(8-16-20)		CLAYEY SAND TO SANDY CLAY (SC-SM) Some Silt, Some to Considerable Clay, Fine Grained Sand, Low to Medium Plasticity, Brown, Very Moist to Wet, Firm		
1,011.8	70			R(20)				
1,006.8	75			S(12-20-27)				
						SAND (SM-SP) Some Silt, Some Fine Gravel, Predominantly Fine Grained, Non Plastic, Brown, Very Moist, Dense		
1,001.8	80							

Sample Type
S-Split Spoon
R-Ring Sampler
A-Drill Cuttings

DMJM ARIZONA, INC.
2777 E. CAMELBACK ROAD
SUITE 200
PHOENIX, AZ. 85016-4302
(602) 337-2777

Project Name: Bethany Home Outfall Channel
Location: Glendale, AZ
Project Number: 6888.0060
Logged By: C. White

BORING LOG NO. 14
Date(s): 06/06/01
Rig & Boring Type: BK 81 HD/8" HSA
Surface Elevation: 1,081.8' ±
Location: Sta 110+98, 120' Rt

Groundwater		
Depth	Hour	Date
None		

Elev (ft)	Depth (ft)	Penetration Rate (Min./Ft)	Sample Interval	Sample Type & (Blowcounts)	Graphical Log	MATERIAL CLASSIFICATION & USCS	LABORATORY ANALYSIS: Dry Density (pcf)	LABORATORY ANALYSIS: Moisture Content (%)
				S(12-18-35)		SAND (SM-SP) Cont'd...		
						STOPPED AUGER @ 80'-0" STOPPED SAMPLER @ 81'-6"		
996.8	85							
	90							
	95							
	100							
	105							
	110							
	115							
	120							

Sample Type
S-Split Spoon
R-Ring Sampler
A-Drill Cuttings

DMJM ARIZONA, INC.
2777 E. CAMELBACK ROAD
SUITE 200
PHOENIX, AZ. 85016-4302
(602) 337-2777

Project Name: Bethany Home Outfall Channel
Location: Glendale, AZ
Project Number: 6888.0060
Logged By: C. White

BORING LOG NO. 15
Date(s): 05/30/01
Rig & Boring Type: BK 81 HD/8" HSA
Surface Elevation: 1,086.0' ±
Location: Sta 117+80, ℄

Groundwater		
Depth	Hour	Date
None		

Elev (ft)	Depth (ft)	Penetration Rate (Min./Ft)	Sample Interval	Sample Type & (Blowcounts)	Graphical Log	MATERIAL CLASSIFICATION & USCS	Dry Density (pcf)	Moisture Content (%)
				S(6-5-5)		CLAYEY SAND (SC) Fine Sand & Clay, Low to Medium Plasticity, Light Brown, Slightly Moist, Soft to Moderately Firm Note: Embankment Fill		
1,081.0	5			S(9-20-24)		SILTY CLAY (CL) Some Fine Sand, Medium to High Plasticity, Dark Brown, Moist, Moderately Firm SANDY CLAY (CL) Fine Sand, Medium Plasticity, Light Brown, Moist, Firm to Very Firm Note: Weak Lime Cement, Slightly Moist, Very Firm Below 5'		
1,076.0	10			R(21-21-31)		CLAYEY SAND (CL-SC) Fine Sand, Medium Plasticity, Light Brown, Moist, Very Firm to Hard Note: Some Coarse Sand & Fine Gravel Below 9.5'		
				A		SILTY CLAY (CL) Some Fine Sand, Medium Plasticity, Brown, Moist, Very Firm to Hard		15
1,071.0	15			S(11-16-21)				
1,066.0	20			R(20-27-30)			105	22
1,061.0	25			S(14-24-27)		Note: Very Moist Below 25'		
						STOPPED AUGER @ 25'-0" STOPPED SAMPLER @ 26'-6"		
1,056.0	30							
	35							
	40							

Sample Type
S-Split Spoon
R-Ring Sampler
A-Drill Cuttings

DMJM ARIZONA, INC.
2777 E. CAMELBACK ROAD
SUITE 200
PHOENIX, AZ. 85016-4302
(602) 337-2777

Project Name: Bethany Home Outfall Channel
Location: Glendale, AZ
Project Number: 6888.0060
Logged By: C. White

BORING LOG NO. 16
Date(s): 05/30/01
Rig & Boring Type: BK 81 HD/8" HSA
Surface Elevation: 1,085.0' ±
Location: Sta 119+72, 2' Lt

Groundwater		
Depth	Hour	Date
None		

Elev (ft)	Depth (ft)	Penetration Rate (Min./Ft)	Sample Interval	Sample Type & (Blowcounts)	Graphical Log	MATERIAL CLASSIFICATION & USCS	Dry Density (pcf)	Moisture Content (%)
				S(8-11-8)		SANDY CLAY (CL) Fine Grained, Medium Plasticity, Light Brown, Slightly Moist, Firm		
1,080.0	5			S(20-30-35)		CLAYEY SAND (SC-CL) Trace of Fine Gravel, Predominantly Medium to Coarse Sand, Medium Plasticity, Light Brown, Slightly Moist to Moist, Very Firm		
1,075.0	10	A		R(21-33-32)			96	21
								9
1,070.0	15			S(17-19-23)		SAND TO SILTY SAND (SP-SM) Some Fine Subround Gravel, Poorly Graded Subangular to Subround Sand, Non Plastic, Grayish Brown to Reddish Brown, Moist, Medium Dense to Dense		
1,065.0	20			R(15-28-45)		Note: Trace to Some Medium to High Plasticity, Reddish Brown Clay In Lenses	121	4
1,060.0	25			S(10-16-23)		SILTY TO SANDY CLAY (CL) Some to Considerable Fine Sand, Medium Plasticity, Brown, Moist, Very Firm		
1,055.0	30					STOPPED AUGER @ 25'-0" STOPPED SAMPLER @ 26'-6"		
	35							
	40							

Sample Type
S-Split Spoon
R-Ring Sampler
A-Drill Cuttings

DMJM ARIZONA, INC.
2777 E. CAMELBACK ROAD
SUITE 200
PHOENIX, AZ. 85016-4302
(602) 337-2777

APPENDIX B – LABORATORY TEST DATA

SUMMARY OF LABORATORY ANALYSIS

CLIENT: DMJM DATE: 06/08/01

PROJECT: Bethany Home Outfall Channel, Ph. II, Final Design

LOCATION: Glendale, Arizona

MATERIAL: See Below SAMPLING DATE: 5/30-31/1

REQUESTED BY: Ammi Osorio, P.E. ATL JOB NO: 199027

BORING No.	DEPTH (Feet)	IN SITU Moist%	USCS	LL	PI	SIEVE ANALYSIS PERCENT PASSING #200	#100	#50	#40	#30	#16	#10	#4	3/8"	3/4"	1.5"	3.0"
3	2.0-5.0	12.4	CL	45	27	66.0	75	86	87	91	95	98	99	100	-	-	-
4	10.0-11.5	7.2	SP-SM	-	NP	10.6	15	25	36	50	72	84	100	-	-	-	-
5	5.0-10.0	9.9	CL	34	15	56.2	66	78	80	84	88	91	95	100	-	-	-
5	15.0-16.5	2.8	SP-SM	-	NP	5.0	8	19	28	40	60	72	100	-	-	-	-
5	35.0-36.5	6.3	SM	-	NP	30.0	34	38	41	46	57	64	72	100	-	-	-
6	10.0-11.0	16.3	CL-ML	26	4	68.1	85	96	97	98	99	99	100	-	-	-	-
6	26.0-28.0	6.5	SM	-	NP	33.3	39	54	61	72	82	88	93	100	-	-	-
6	40.0-41.5	4.3	SP-SM	-	NP	8.4	13	24	38	56	81	90	100	-	-	-	-
6	60.0-61.5	33.1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
6	70.0-71.0	5.1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	0.0-5.0	7.9	CL	38	19	55.5	70	82	86	90	92	94	97	99	100	-	-
1	5.0-6.5	17.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	12.0-15.0	12.9	SC	57	38	46.5	57	68	72	78	87	94	100	-	-	-	-
2	8.0-10.0	18.6	CL	45	25	79.4	87	91	92	96	98	99	100	-	-	-	-
7	8.0-10.0	14.1	CL	45	23	51.0	64	75	79	83	90	93	100	-	-	-	-
8	5.0-10.0	10.7	CL	38	20	67.6	79	88	91	93	96	97	99	100	-	-	-
9	2.0-5.0	11.9	CL	29	12	61.2	71	84	86	90	94	96	98	100	-	-	-
10	4.0-7.0	15.1	CL	45	24	59.6	69	81	82	86	90	92	95	100	-	-	-
10	15.0-16.5	19.0	CL	34	13	56.7	67	78	82	86	92	96	100	-	-	-	-
11	2.0-5.0	10.9	SC	25	8	49.6	64	78	83	87	93	97	100	-	-	-	-
12	5.0-8.0	6.5	SC	43	19	21.0	29	39	42	49	62	78	100	-	-	-	-
15	12.0-15.0	14.9	SC	44	21	45.1	56	66	70	75	85	91	100	-	-	-	-
15	20.0-21.5	20.8	CL	40	18	67.5	80	89	93	95	98	99	100	-	-	-	-

SUMMARY OF LABORATORY ANALYSIS

CLIENT: DMJM DATE: 06/08/01

PROJECT: Bethany Home Outfall Channel, Ph. II, Final Design

LOCATION: Glendale, Arizona

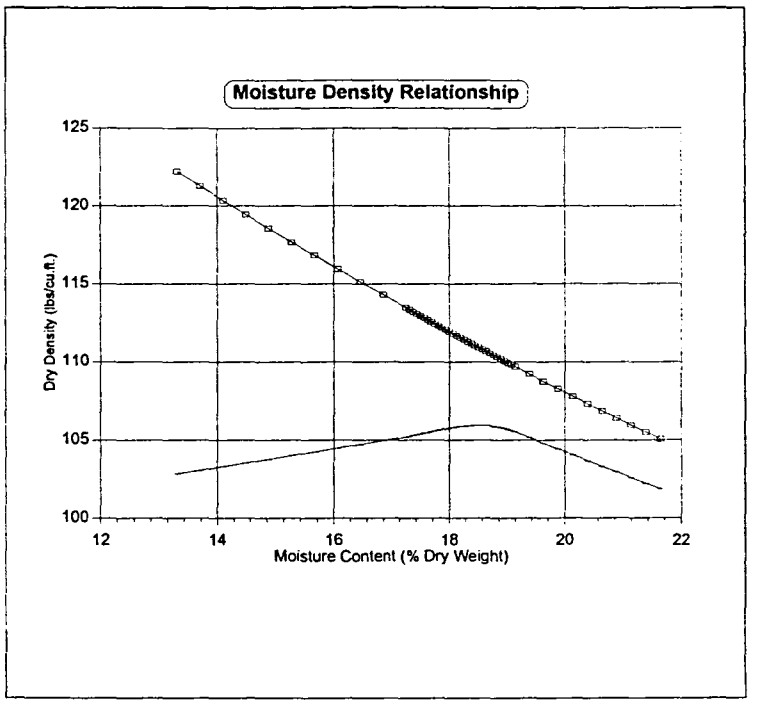
MATERIAL: See Below SAMPLING DATE: 5/30-31/1

REQUESTED BY: Ammi Osorio, P.E. ATL JOB NO: 199027

BORING No.	DEPTH Feet	IN-SITU Moist %	USCS	LL	PI	SIEVE ANALYSIS - PERCENT PASSING											
						#200	#100	#50	#40	#30	#16	#10	#4	3/8	3/4	1.5	3.0
16	10.0-11.5	20.6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
16	10.0-15.0	9.2	CL	42	18	58.9	65	73	77	80	86	91	97	100	-	-	-
16	20.0-21.5	3.6	SP-SM	-	NP	5.0	7	13	18	24	38	52	75	91	96	100	-
3	5.0-6.5	15.8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
5	5.0-6.5	12.7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Summary of Moisture Density Relationship Tests

Client:	DMJM	Job No.	199027
Address:	2777 E. Camelback Road, Ste 200	Lab No.	01-0778
	Phoenix, AZ 85016	Type of Rammer:	Manual
		Sample Date:	05/31/01
Project:	Bethany Home Outfall Channel-Phase II	Material Description:	Brown, CL
	Final Design	Material Source:	Boring No. 16, Depth: 10.0' - 15.0'
Test Designation:	ASTM D-698		
Test Method:	A	Report Date:	6/08/01
Tested By:	LS		



Bulk Specific Gravity for Rock Correction (+#4): 2.650 estimate

Specific Gravity Used For Zero Air Voids Curve Calculation: 2.650

Test No.	1	2	3	4
Dry Density (lbs/cu.ft.)	102.8	105.2	105.5	101.8
Moisture Content (%)	13.3	17.2	19.1	21.6

Maximum Dry Density (lbs/cu.ft.): **106.0**

Optimum Moisture Content (% of Dry Weight): **18.5**

Percent of Retained Oversized Particles:

Maximum Dry Density For Oversize Particles (D4718):

Corrected Moisture Content For Oversized Particles (D4718):

Remarks:

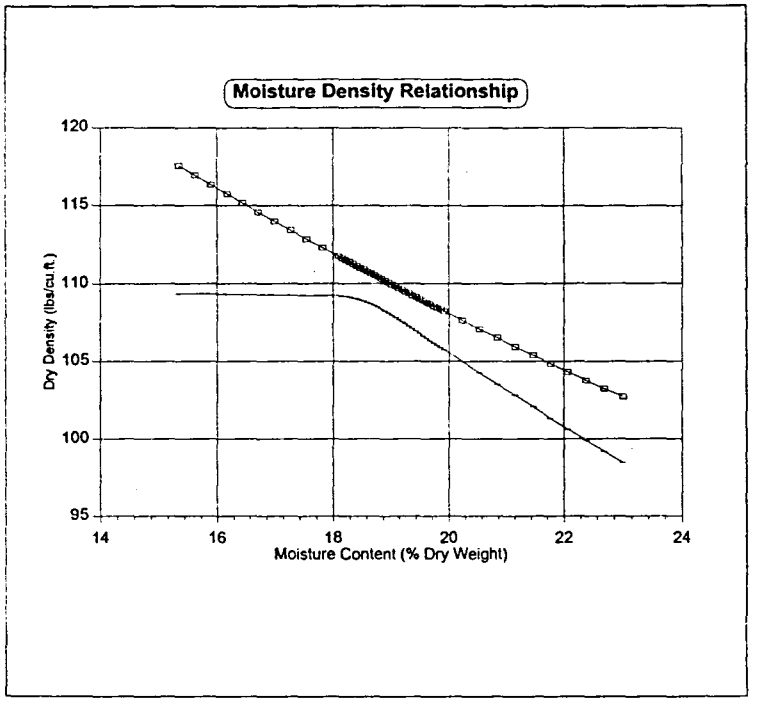
Respectfully Submitted:
ATL, INC.

Miguel Cancino
Central Laboratory Supervisor

Reviewed by

Summary of Moisture Density Relationship Tests

Client:	DMJM	Job No.	199027
Address:	2777 E. Camelback Road, Ste 200	Lab No.	01-0764
	Phoenix, AZ 85016	Type of Rammer:	Manual
		Sample Date:	05/31/01
Project:	Bethany Home Outfall Channel-Phase II	Material Description:	Brown, CL
	Final Design	Material Source:	Boring No. 8, Depth: 5.0' - 10.0'
Test Designation:	ASTM D-698		
Test Method:	A	Report Date:	6/08/01
Tested By:	LS		



Bulk Specific Gravity for Rock Correction (+#4): 2.650 estimate

Specific Gravity Used For Zero Air Voids Curve Calculation: 2.650

Test No.	1	2	3	4
Dry Density (lbs/cu.ft.)	109.4	109.2	105.7	98.5
Moisture Content (%)	15.3	18.1	19.9	23.0

Maximum Dry Density (lbs/cu.ft.): **109.4**

Optimum Moisture Content (% of Dry Weight): **18.1**

Percent of Retained Oversized Particles:

Maximum Dry Density For Oversize Particles (D4718):

Corrected Moisture Content For Oversized Particles (D4718):

Remarks:

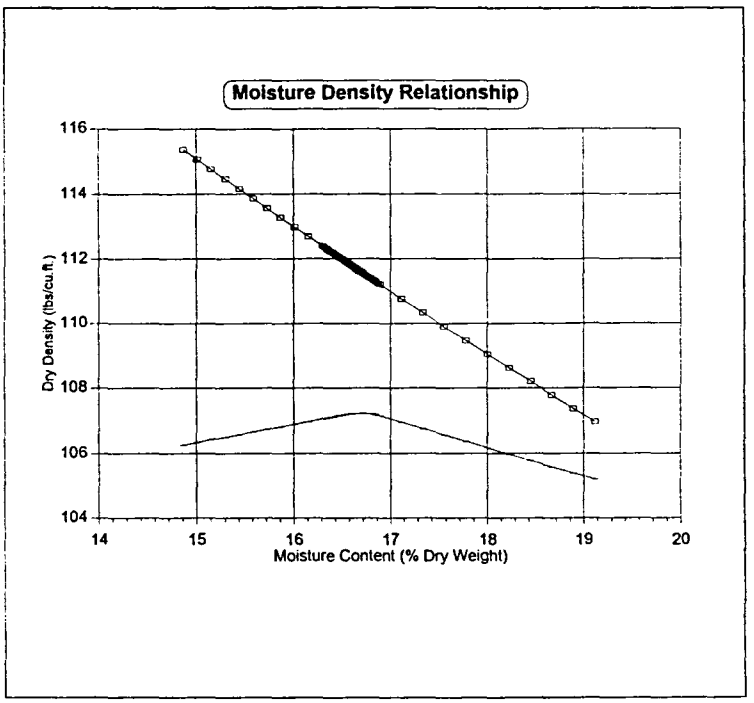
Respectfully Submitted:
ATL, INC.

Miguel Caccino
Central Laboratory Supervisor

Reviewed by:

Summary of Moisture Density Relationship Tests

Client:	DMJM	Job No.	199027
Address:	2777 E. Camelback Road, Ste 200	Lab No.	01-0747
	Phoenix, AZ 85016	Type of Rammer:	Manual
		Sample Date:	05/30/01
Project:	Bethany Home Outfall Channel-Phase II	Material Description:	Brown, CL
	Final Design	Material Source:	Boring No. 3, Depth: 2.0' - 5.0'
Test Designation:	ASTM D-698		
Test Method:	A	Report Date:	6/08/01
Tested By:	GR		



Bulk Specific Gravity for Rock Correction (+#4): 2.550 estimate

Specific Gravity Used For Zero Air Voids Curve Calculation: 2.550

Test No.	1	2	3	4
Dry Density (lbs/cu.ft.)	106.3	107.1	107.2	105.2
Moisture Content (%)	14.9	16.3	16.9	19.1

Maximum Dry Density (lbs/cu.ft.): **107.2**

Optimum Moisture Content (% of Dry Weight): **16.7**

Percent of Retained Oversized Particles:

Maximum Dry Density For Oversize Particles (D4718):

Corrected Moisture Content For Oversized Particles (D4718):

Remarks:

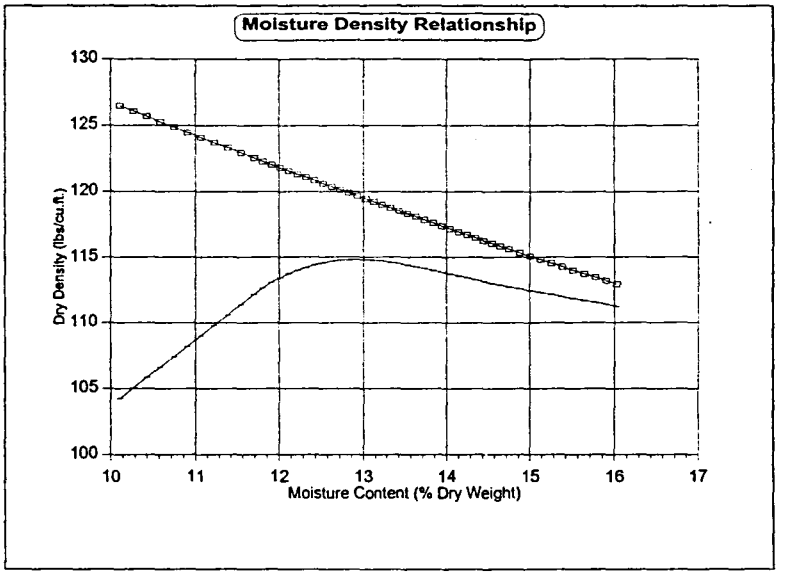
Respectfully Submitted:
ATL, INC.

Miguel Cancino
Central Laboratory Supervisor

Reviewed by:

Summary of Moisture Density Relationship Tests

Client:	DMJM	Job No.	199027
Address:	2777 E. Camelback Road, Ste 200	Lab No.	01-0749
	Phoenix, AZ 85016	Type of Rammer:	Manual
		Sample Date:	5/30/01
Project:	Bethany Home Outfall Channel-Phase II	Material Description:	Brown, CL
	Final Design	Material Source:	Boring No. 5, Depth: 5.0' - 10.0'
Test Designation:	ASTM D-698		
Test Method:	A	Report Date:	6/08/01
Tested By:	GR/EF		



Bulk Specific Gravity for Rock Correction (+#4): 2.550 estimate

Specific Gravity Used For Zero Air Voids Curve Calculation: 2.550

Test No.	1	2	3	4
Dry Density (lbs/cu.ft.)	104.2	112.2	112.8	111.3
Moisture Content (%)	10.1	11.7	14.8	16.0

Maximum Dry Density (lbs/cu.ft.): **114.8**

Optimum Moisture Content (% of Dry Weight): **12.9**

Percent of Retained Oversized Particles: !

Maximum Dry Density For Oversize Particles (D4718):

Corrected Moisture Content For Oversized Particles (D4718):

Remarks:

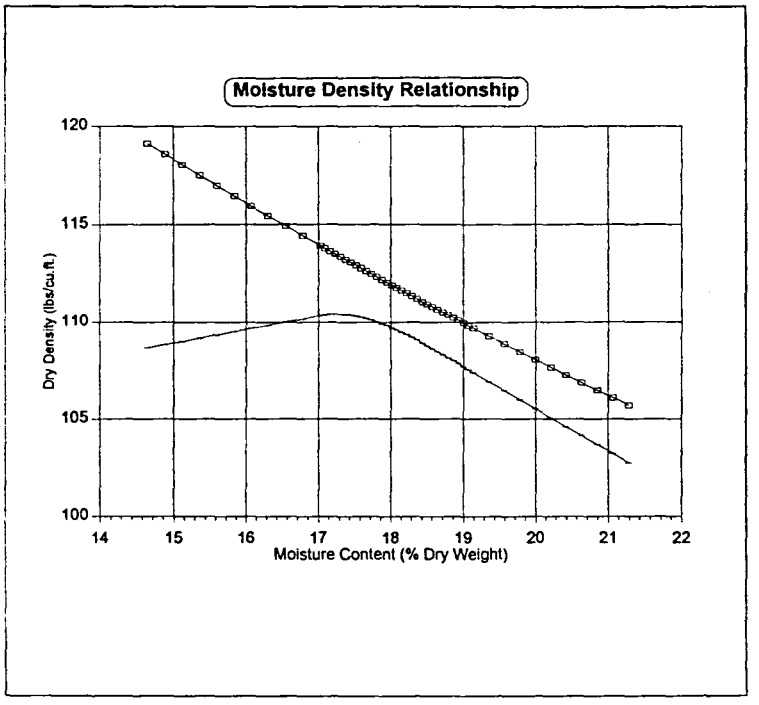
Respectfully Submitted:
ATL, INC.

Miguel Cancino
Central Laboratory Supervisor

Reviewed by

Summary of Moisture Density Relationship Tests

Client:	DMJM	Job No.	199027
Address:	2777 E. Camelback Road, Ste 200	Lab No.	01-0759
	Phoenix, AZ 85016	Type of Rammer:	Manual
		Sample Date:	05/31/01
Project:	Bethany Home Outfall Channel-Phase II	Material Description:	Brown, CL
	Final Design	Material Source:	Boring No. 1, Depth: 0.0' - 5.0'
Test Designation:	ASTM D-698		
Test Method:	A	Report Date:	6/08/01
Tested By:	GT		



Bulk Specific Gravity for Rock Correction (+#4): 2.650 estimate

Specific Gravity Used For Zero Air Voids Curve Calculation: 2.650

Test No.	1	2	3	4
Dry Density (lbs/cu.ft.)	108.7	110.3	107.4	102.7
Moisture Content (%)	14.7	17.0	19.1	21.3

Maximum Dry Density (lbs/cu.ft.): **110.4**

Optimum Moisture Content (% of Dry Weight): **17.3**

Percent of Retained Oversized Particles:

Maximum Dry Density For Oversize Particles (D4718):

Corrected Moisture Content For Oversized Particles (D4718):

Remarks:

Respectfully Submitted:
ATL, INC.

Miguel Cancino
Central Laboratory Supervisor

Reviewed by:

ATL, Inc.
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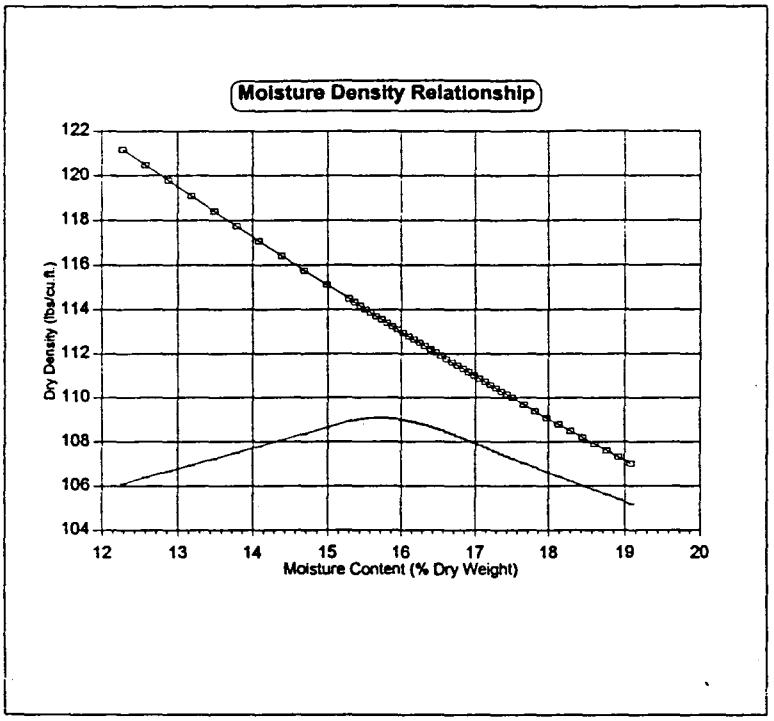
Summary of Moisture Density Relationship Tests

Client:	DMJM	Job No.	199027
Address:	2777 E. Camelback Road, Ste 200	Lab No.	01-0812
	Phoenix, AZ 85016	Type of Rammer:	Manual
		Sample Date:	06/06/01
Project:	Bethany Home Outfall Channel-Phase II	Material Description:	Brown, SC
	Final Design	Material Source:	Boring No. 14, Depth: 5.0' - 10.0'
Test Designation:	ASTM D-698		
Test Method:	A	Report Date:	06/18/01
Tested By:	EF		



Bulk Specific Gravity for Rock Correction (+#4): 2.550 estimate
Specific Gravity Used For Zero Air Voids Curve Calculation: 2.550

Test No.	1	2	3	4
Dry Density (lbs/cu.ft.)	106.1	108.9	107.3	105.2
Moisture Content (%)	12.3	15.3	17.5	19.1

Maximum Dry Density (lbs/cu.ft.): **109.1**
Optimum Moisture Content (% of Dry Weight): **15.7**
Percent of Retained Oversized Particles:

Maximum Dry Density For Oversize Particles (D4718):
Corrected Moisture Content For Oversized Particles (D4718):

Remarks:

Respectfully Submitted:
ATL, INC.

Miguel Cardino
Central Laboratory Supervisor

Reviewed by:

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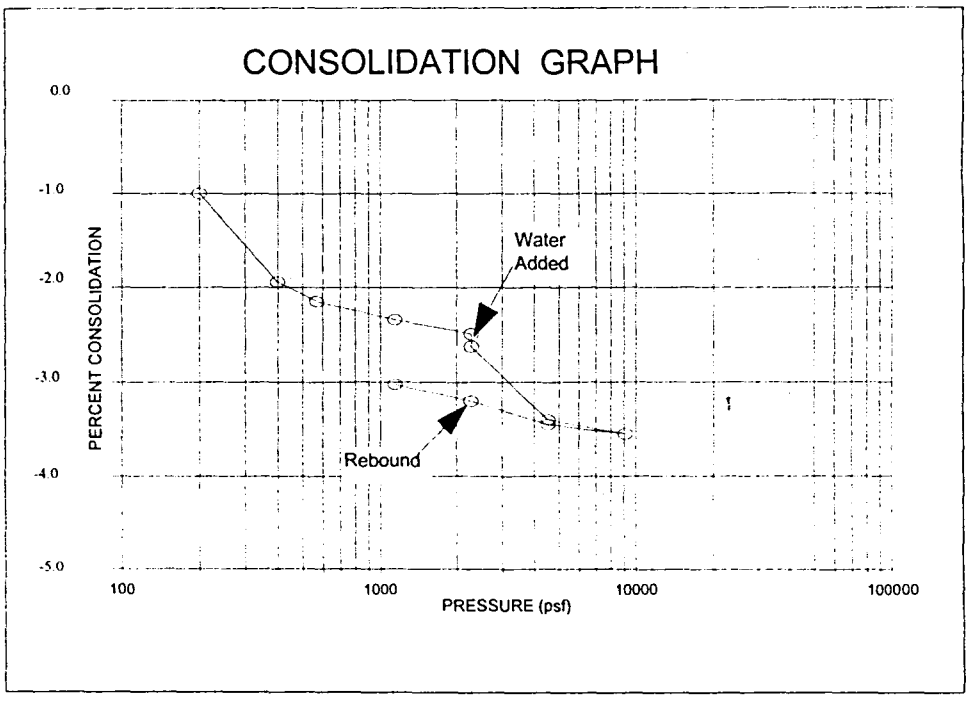
CONSOLIDATION TEST
(ASTM D-2435)

Client:	DMJM	**Lab No.:**	01-0752
Project Name :	Bethany Home Outfall Channel, Final Design	**Test Date:**	05/30/01
Project No. :	199027	**Sample Location:**	Boring No.: 6
Initial Reading:	0.2000		Depth:10.0' - 11.0'
Dry Density:	126.4 pcf	**Soil Description:**	Brown, CL-ML
Moisture Content:	Before: 2.7% After: 26.3%		

LOAD (tsf)	LOAD (psf)	DIAL READING	PERCENT CONSOLIDATION
0.05	100	0.2001	-0.01
0.10	200	0.2100	-1.00
0.20	400	0.2194	-1.94
0.29	570	0.2215	-2.15
0.57	1140	0.2234	-2.34
1.14	2280	0.2249	-2.49
1.14	2280	0.2262	-2.62
2.28	4560	0.2340	-3.40
4.56	9120	0.2355	-3.55
2.28	4560	0.2345	-3.45
1.14	2280	0.2320	-3.20
0.57	1140	0.2302	-3.02



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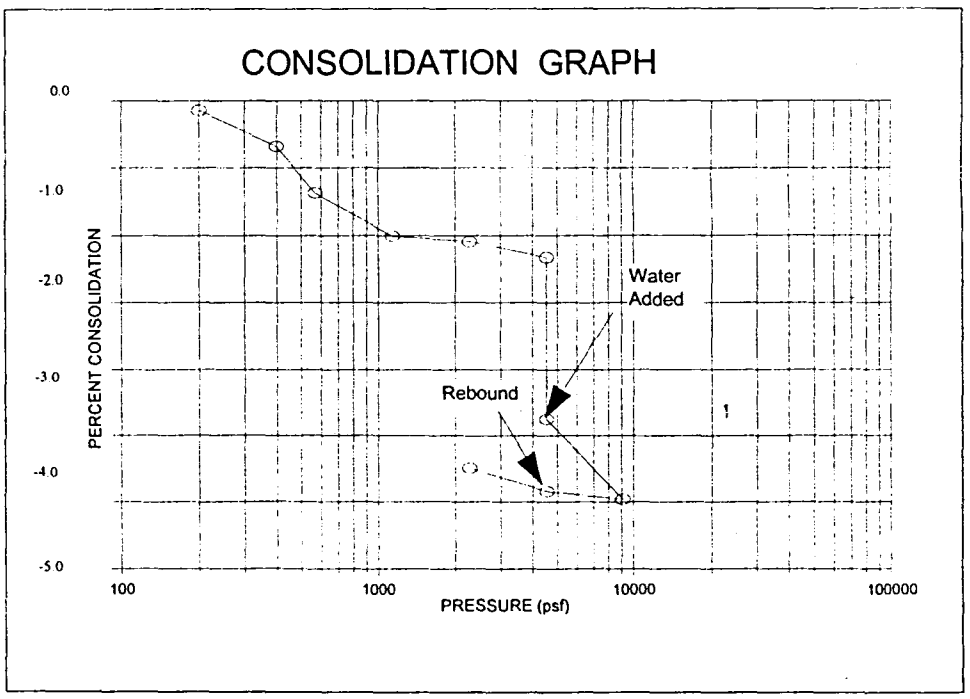
CONSOLIDATION TEST
(ASTM D-2435)

Client:	DMJM	**Lab No.:**	01-0766
Project Name :	Bethany Home Outfall Channel, Final Design	**Test Date:**	06/08/01
Project No. :	199027	**Sample Location:**	Boring No.: 8
Initial Reading:	0.2000		Depth:15.0' - 16.0'
Dry Density:	121.6 pcf	**Soil Description:**	Brown, CL
Moisture Content:	Before: 7.3% After: 15.8%		

LOAD (tsf)	LOAD (psf)	DIAL READING	PERCENT CONSOLIDATION
0.05	100	0.1988	0.12
0.10	200	0.2014	-0.14
0.20	400	0.2067	-0.67
0.29	570	0.2137	-1.37
0.57	1140	0.2201	-2.01
1.14	2280	0.2209	-2.09
2.28	4560	0.2232	-2.32
2.28	4560	0.2475	-4.75 *
4.56	9120	0.2596	-5.96
2.28	4560	0.2584	-5.84
1.14	2280	0.2549	-5.49



Note: * Water was added on the specimen at 4560 psf

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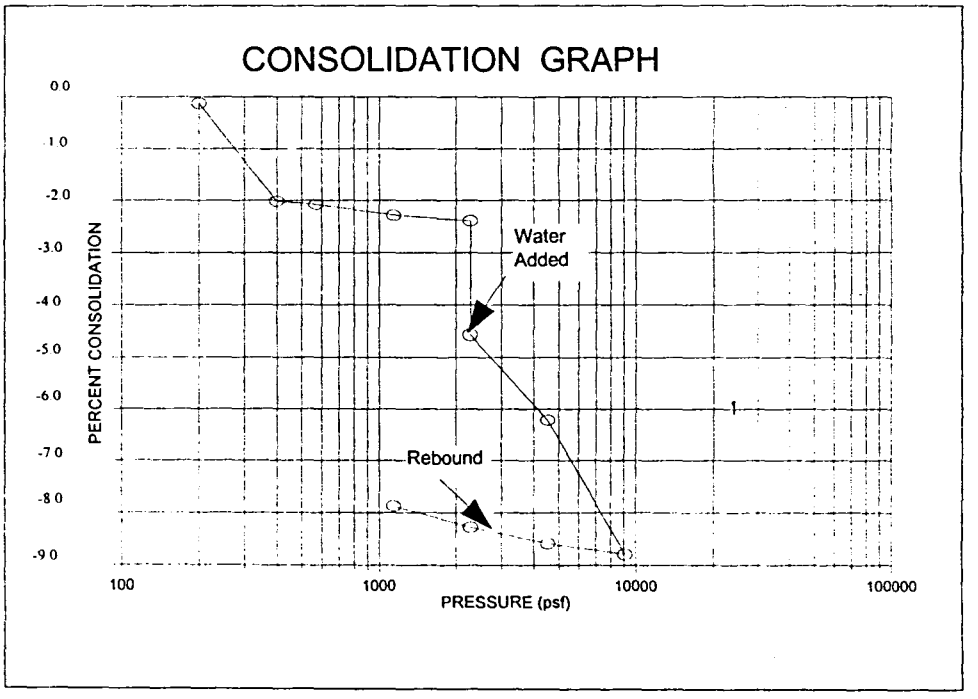
CONSOLIDATION TEST
(ASTM D-2435)

Client:	DMJM	**Lab No.:**	01-0768
Project Name :	Bethany Home Outfall Channel, Final Design	**Test Date:**	05/30/01
Project No. :	199027	**Sample Location:**	Boring No.: 9
Initial Reading:	0.2000		Depth:10.0' - 11.5'
Dry Density:	101.4 pcf	**Soil Description:**	Brown, CL
Moisture Content:	Before: 13.3% After: 20.2%		

LOAD (tsf)	LOAD (psf)	DIAL READING	PERCENT CONSOLIDATION
0.05	100	0.1999	0.01
0.10	200	0.2012	-0.12
0.20	400	0.2202	-2.02
0.29	570	0.2208	-2.08
0.57	1140	0.2229	-2.29
1.14	2280	0.2240	-2.40
1.14	2280	0.2457	-4.57
2.28	4560	0.2621	-6.21
4.56	9120	0.2880	-8.80
2.28	4560	0.2859	-8.59
1.14	2280	0.2828	-8.28
0.57	1140	0.2787	-7.87



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DIRECT SHEAR TEST DATA

Client:	DMJM	**Job No.:**	199027
	2777 E. Camelback Road, Ste 200	**Lab No.:**	See Below
	Phoenix, AZ 85016	**Sampled By:**	Client
Attn:	Mr. Keith Dahlen, P.E.	**Test Date:**	06/06/01
Project:	Bethany Home Outfall Channel Phase II, Final	**Tested by:**	D. Johnson
Source of Material:	See Below	**Material Type:**	See Below

Boring No.	Depth (Ft)	Lab No.:	Internal Friction Angle	Moisture Content (%)	Dry Density (pcf)
Boring No. 14	10.0-11.0	01-0810	38°	21.0	93.3

Remarks:

Reviewed By:
Input By: AO

Respectfully submitted,

Miguel M. Cancino
Central Laboratory Supervisor

Direct Shear/BHOC

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SOIL CHEMICAL ANALYSIS

Client:	DMJM	**Job No.:**	199027
	2777 E. Camelback Road, Ste 200	**Lab Nos.:**	See Below
	Phoenix, AZ 85016	**Sampled By:**	Client
Attn:	Keith Dahlen, P.E,	**Test Date:**	06/19/01
Project:	Bethany Home Outfall Channel-Phase II	**Tested by:**	IAS
Source of Material:	Stockpile @ MP 263 Westbound	**Type of Material:**	See Below

Sample Location:	Material Type:	pH	Sulfates SO4-S (ppm)	Chloride (ppm)
Boring No.5, 12'-14'	SP-SM	8.4	19	60
Boring No.8, 5'-6.5'	CL	8.5	19	40
Boring No.13, 18'-20'	-	8.6	12	30
Boring No.15, 5'-6.5'	-	8.1	55	130

Remarks:

Respectfully submitted,

Reviewed By:
Input By: AO

Miguel M. Cancino
Central Laboratory Supervisor

pHSulfatesChlorides/BHOC

APPENDIX C – ATL Test Boring Log (Preliminary Investigation)

BETHANY HOME ROAD OUTFALL CHANNEL - PHASE II
FCD 98-46
Pre-Design Stage

ATL Job No. 199027

Boring No.: 1

Location: 29 feet north of north edge Bethany Home
23 feet east of east edge 83rd Ave.

Boring Equipment: CME 55 6 5/8" auger

Date of Boring: 9/24/99 **Elevation of Boring:** Existing grade **Driller:** Manny with Enviro **Logger:** K. Phillips **Reviewed By:** A. Osorio

Graphical Log	Depth (Feet)	SOIL DESCRIPTION	SPT Blows/ft	Ring Blows/ft	Water Content %	Dry Density (pcf)
		Brown, clayey SAND(SC) with gravel, slightly moist		23		
	5		13			
	10		16			
	15	Dark brown, sandy lean CLAY(CL), moist	20			
	20	(Boring was Terminated at 20 feet below grade)				
	25					

Boring was Terminated at 20' below Existing Grade

Groundwater	Initial Depth	Hour	24 Hour Depth
	None		

NOTE: THE ABOVE DATA FOR DESIGN PURPOSES ONLY.

APPENDIX D – ATL Laboratory Test Data (Preliminary Investigation)

ATL

SUMMARY OF LABORATORY ANALYSIS

CLIENT: DMJM ARIZONA, INC. DATE: 11/15/99

PROJECT: BETHANY HOME ROAD OUTFALL CHANNEL - PHASE II PRE-DESIGN STAGE

LOCATION: GLENDALE - PHOENIX, ARIZONA

MATERIAL: See Below SAMPLING DATE: 09/24/99

REQUESTED BY: David Hayes ATL JOB NO: 199027

BORING No.	DEPTH (Feet)	IN-SITU Moist.%	USCS	LL	PI	SIEVE ANALYSIS - PERCENT PASSING #200	#100	#50	#40	#30	#16	#10	#4	3/8"	3/4"	1.5"	3.0"
1	0 - 5	5.8	SC	27	10	33.6	40	51	56	59	65	70	76	88	96	100	-
1	10 - 15	9.2	SC	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2	0 - 5	5.3	SC	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2	10 - 15	13.2	CL	35	17	60.5	65	73	76	78	83	87	92	98	100	-	-
3	0 - 5	13.0	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3	5 - 10	24.5	CL - ML	26	7	61.6	72	96	98	99	100	100	100	-	-	-	-

BETHANY HOME ROAD OUTFALL CHANNEL - PHASE II
FCD 98 - 46
PRE-DESIGN STAGE
ATL JOB NO. 199027

DRY UNIT WEIGHT

Boring No.	USCS	Sample Depth (ft.)	Dry Unit Weight (pcf)
1	SC	2.5 - 3	98.8
3	CL	2.5 - 3	93.2

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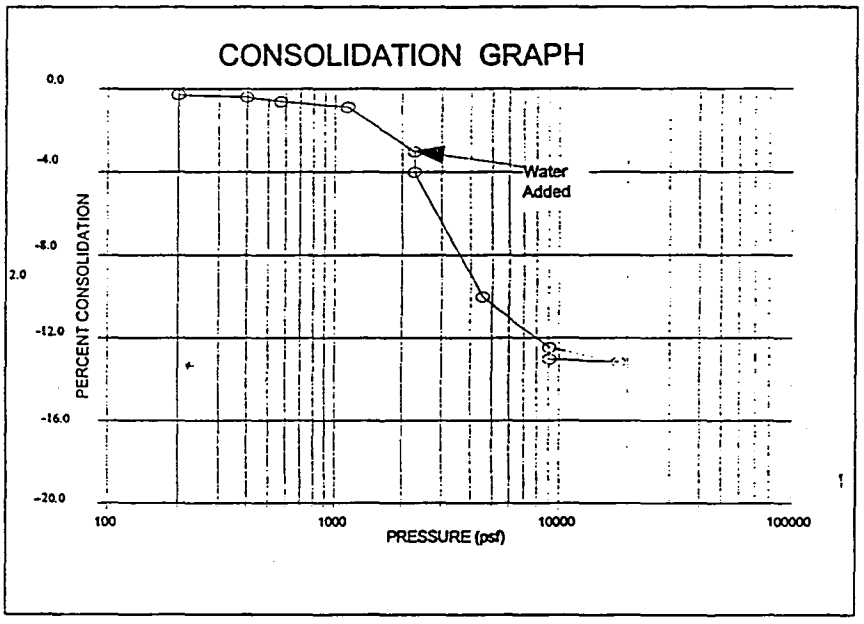
CONSOLIDATION TEST
(ASTM D-2435)

Client:	DMJM	**Lab No.:**	99-1103
Project Name :	Bethany Home Road Outfall Channel	**Test Date:**	12/22/99
Project No. :	199027	**Sample Location:**	Boring No.: 1
Initial Reading:	0.2000		Depth:20.5' - 21.0'
Dry Density:	111.7 pcf	**Soil Description:**	Dark brown, sandy lean CLAY(CL)
Moisture Content:	Before: 3.15 % After: 15.7 %		

LOAD (tsf)	LOAD (psf)	DIAL READING	PERCENT CONSOLIDATION
0.05	100	0.2013	-0.13
0.10	200	0.2027	-0.27
0.20	400	0.2038	-0.38
0.29	570	0.2060	-0.60
0.57	1140	0.2088	-0.88
1.14	2280	0.2302	-3.02
1.14	2280	0.2400	-4.00
2.28	4560	0.3000	-10.00
4.56	9120	0.3245	-12.45
9.12	18240	0.3315	-13.15
4.56	9120	0.3300	-13.00



BETHANY HOME ROAD OUTFALL CHANNEL - PHASE II
FCD 98-46
PRE-DESIGN STAGE
ATL JOB NO. 199027

pH AND RESISTIVITY TESTS

Boring No.	Depth (Ft)	USCS	pH	Soil Resistivity (ohms - cm)
1	0 - 5	SC	8.28	2917
2	0 - 5	SC	8.05	530
3	0 - 5	CL	7.92	398